Discover Science @UWS: Motivating science students to select science as a field to study and as a career.

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Abstract

In an increasingly competitive global economy in which Australia markets its knowledge, science and innovation the current and growing shortfall of science industry workers is an ongoing crisis. The focus of this paper is the evaluation of an initiative that addressed the issue of student negative attitudes to science and the movement away from science as a career or focus of tertiary study. The problem begins with the choices that secondary students make when considering subjects for their senior years of schooling. Students are not linking classroom science to study and careers in a broad range of scientific fields. In the Discover Science @UWS program Year 10 and 11 students worked with Australian university scientists in the Confocal Bio-imaging facility performing authentic experiments using cutting edge technology. The evidence of the impact on student learning lies in the extensive two way transfer of information between the scientists, students and their teachers and way the students demonstrated a deeper understanding of complex scientific concepts and their increased confidence in being able to present their findings to a scientific audience. The students' perspectives of studying science at university and career choices were modified, but in some cases, not enough to move away from familial expectations for future study and careers.

Introduction

The teaching and learning of science, both in Australia and overseas, is under critical review and studies show that students' positive attitudes towards science are in decline (Fensham, 2006; Logan & Skamp, 2004; Holstein & Lunetta, 2004; Gregson, 2003; Rennie, Goodrum & Hackling, 2001). Students believe that learning about science is important and report experiencing enjoyment, satisfaction, increased motivation, development of self-esteem, and improvement in their ability to solve problems as outcomes from practical activities that are a component of science curricula (Hofstein & Lunette, 2004; Gregson, 2003). However they find "science hard, in particular physics and chemistry, which leads them to find science uninteresting" (Osbourne and Collins, 2001, p. 449). There are grounds to suspect that current syllabuses, classroom pedagogies and assessment strategies are failing to promote an interest in science as high achieving students fail to select science at tertiary level to become scientists or science teachers (Fensham, 2006; Keeves, 2004; Gregson, 2003). Beyond the dreams of medicine, veterinary studies or dentistry students appear unaware of the breadth of opportunities available to them through the study of science.

The Discover Science @UWS program was designed to provide an opportunity for students to have exposure to scientists working in scientific facilities with modern technology. It was hypothesised that through engagement with industry on a practical level the misconceptions about science, as a career choice, could to some extent be overcome. The program facilitated the partnership between an industry partner, University of Western Sydney (UWS) and 12 students and three teachers from three government secondary schools where the industry partner was particularly interested in establishing a program that motivated students to study and then seek employment in science related positions. The students and their teachers spent four full days with the scientists in the confocal bio-imaging facility participating in formal lecture sessions using the cutting edge equipment. They used the new knowledge and skills to explore the effect of current pharmaceutical drugs on cells and reported their findings on a poster.

The question to be addressed was whether the involvement in such a program leads to greater understanding of science and increased interest in studying science at tertiary level and a career in scientific work places. This work is important if there is to be a successful model for engaging students in a variety of contexts where the focus is on providing learning experiences that will show students the options for learning and working in science.

As an enrichment activity for secondary students the program was successful in demonstrating the ability of these students to engage with scientists and cutting edge technology. They were able to present highly complex findings to an audience of experienced scientists from an international pharmaceutical company. They were applauded for their ability to utilise sophisticated scientific language and present their findings with confidence and clarity. However, while the students acknowledged the significance of the opportunity they had in the Discover Science @UWS program and the benefits they perceived in terms of increased understanding and motivation for their studies there was little evidence that any change in their views on a career in science would lead to them choosing science over preconceived notions of studying medicine or following in family footsteps.

Current state of knowledge

Retention of science students

In both Australian and overseas schools the decline of interest in science has been reported to begin as early as late primary school (George, 2006). The consequences of the disengagement with science in schools in New South Wales can be seen in the difference in numbers of students who sit for the compulsory external science examination in Year 10 compared with the number that choose a science for the Higher School Certificate in Year 12 (Office of the Board of Studies shown in table 1).

Table 1: Highlights the trend in numbers of students who are sitting the Higher School Certificate in science compared to the numbers sitting for the compulsory science examination for the School certificate.

School Certificate Year 10	Higher School Certificate Year 12	Decline in numbers
2003	2005	42 446
2004	2006	42 459
2005	2007	43 864

The decline has been attributed to several factors. The student perception of the difficulty of science, the quality of the teaching of science, the absence of authentic tasks, a lack of public understanding of science, limited financial rewards, curriculum relevance and community engagement are highlighted as issues in the teaching of science (Fensham, 2006; Skamp and Logan, 2005; Darby 2005; Gregson, 2003; Rennie, Goodrum & Hackling, 2001). The limitations of resources, the value placed on the study of science and the competing interests of other teaching priorities will also be identified as pivotal in this project. Students spend less than 20% of their time in school and when in school less than 20% in science classrooms (Goodrum & Rennie, 2007, p.27).

Syllabus requirements and teaching of science

With the aim of science education being the development of scientific literate citizens who show interest in scientific concepts and can make informed decisions about solutions for issues there is doubt about the amount of science taught in schools and the level of student engagement leading to such outcomes (Palmer, 2008). Primary teachers report the low priority given to science in a crowded curriculum and typically teacher centred approaches used in secondary science classrooms have lead to a decline in interest in science (Rennie et.al 2001). Based on the findings of Lyons (2006a), Palmer suggests that a more practical and involved pedagogy that can connect employers and industry to students can form part of the engaging learning that students find more interesting and relevant.

Current teaching practices

There is concern that in many Australian schools science lessons do not cultivate student engagement particularly during the compulsory years of secondary schooling where many students find science unrelated to their interests or concerns (Tytler, 2007; Rennie, Goodrum & Hackling, 2001). Nor are current pedagogies producing learning outcomes that help promote careers in science or science teaching as high achieving students are failing to choose to study science at tertiary level (Fensham, 2006). While there is an emphasis on developing teacher knowledge of constructivist practices in teaching training courses the reality in science classrooms more closely reflects traditional pedagogy of chalk and talk and internet searches.

Authentic Tasks

Contemporary thinking in science education places emphasis on conceptual learning through a variety of learning processes that include providing authentic hands-on investigations and group learning (Appleton & Kindt, 1999, p. 155) and opportunities for engagement in critical thinking and working scientifically using a range of literacy skills (Skamp, 2004). Authentic tasks have real-world relevance, matching tasks and assessment with professional experience. These tasks frequently generate outcomes that are perceived, by students, to have greater satisfaction than textbook based exercises (Woo, Herrington, Agostino & Reeves, 2007). However the latest syllabuses, whilst requiring teachers "to use contexts that integrate knowledge and understanding [and] skills …and increase the potential for learning to take place" (Board of Studies NSW, 2000, p10), do not fully articulate the pedagogy directing teachers to integrate theory and practical experiences, or specify contexts as being laboratory, or even field or other 'real world' situations.

These recurring themes about student motivation found in educational literature provide support for the Discover Science @UWS program. That to make it real (Brozo, 2005) provide choices (Reeve & Hyungshim, 2006), balance the challenge (Magolis & McCabe, 2006), provide role models (Magolis & McCabe, 2006) and provide a supportive classroom climate (Reeve & Hyungshim, 2006) enhance student motivation. All of these elements have been incorporated into the Discover Science @UWS program.

Selection of science for tertiary study

While more students are entering tertiary institutions the numbers choosing mathematics and chemistry are fewer (HESA, 2005). In a study of 50 schools in the United Kingdom it is noted that while students are still enjoying science they suggested that physics is too hard and unlikely to earn them financial rewards. Lyons (2006b) also highlights the link between the decision to enroll in science and a student's future aspirations, family background and the prestige perceived around science as a career. Many responses proposed that the aspirations of students to progress into university to some extent underpinned their choice of doing science in high school even if their interest in science was not high (p. 293). The science subjects, in particular Physics and Chemistry are perceived as a gateway to the highly desired professions of medicine and engineering.

Rennie, Goodrum & Hackling (2001) suggest that resource allocation is a hindrance to the development of science students into future science professionals. Their argument centres on the rhetoric, particularly from governments, of what science education is supposed to achieve and the actual outcomes. The gap that is exposed between the ideal and the reality draws comparison to that identified by Hassan and Treagust (2003) and comparable solutions are also suggested. The focus of their finding instead rests on the lack of a national strategy and while relevant it can be argued that a national curriculum will not adequately address the specific problems of student disinterest in science.

The role of industry

While the task of increasing the involvement of students in science is partially identified as an area where schools, governments, universities and private enterprise can collaborate there is no explicit framework for how this can be approached (Goodrum & Rennie, 2007, p.28). Approaches similar to Discover Science @UWS have been utilised to overcome more recent skilled work shortages and have been relatively successful in reversing worker shortage trends. Through engagement with industry on a practical level the misconceptions about science and the science industry can effectively overcome many of the readily identified shortcomings of the current discourse.

Research Design and Method

Context of the study

The Discover Science@UWS program students was developed to build on the students' current knowledge of biology, physics, chemistry and mathematics reflected in NSW senior science syllabuses. In addition it also provided exploration of concepts beyond the scope of these syllabuses and engagement with scientists who were performing cutting edge science investigations using the Confocal Bio-imaging microscope. With the support of their teachers and university scientists the participating students developed skills and understanding of scientific concepts that enhanced their learning of identified syllabus outcomes. During the process of gaining the skills and knowledge the author evaluated the students learning and the impact that the experience had on the students, their science teachers and the university staff. It was anticipated that the collection and analysis of the data would lead to the development of a model providing the structure for sustainable engagement between industry, schools and universities.

Participants

UWS

Two UWS academics Drs. Jones and Gregson worked with the Office of Engagement, three science teachers and the industry partner to develop a program that supported students and science teachers during the project by collaborating with teachers to develop appropriate tasks for the students and facilitating the processes and production of key deliverables including posters, DVD, podcast/s and TVS through liaison with university marketing and media departments. Three honours and one doctoral student volunteered to be advisors. They provided the hands-on instruction of the use of the equipment and on –line discussions to help the students. One advisor was assigned to a school group and the fourth acted as a floater between the groups.

Science Teachers

Three science teachers from NSW public high schools took part in the project. They are all motivated teachers and enthusiastic in being part of the project as learners and facilitators. They were responsible for the selection process used in their particular school for choosing the students that will be the focus of the project.

Students

There were 12 student participants (four students from each school). At the initial planning meeting it was decided that two students from year 10 and 11 would provide support for each other but also allow for sustainability of the project as the Year 11 students would be able to mentor the year 10 students who may be part of the project in Year 11 as mentors for the incoming year 10 students.

Research question

Will involvement in the enrichment program 'discover science@uws' change the perceptions, interest and motivation for further study of science at school and/or university?

Data collection

This mixed methods research project reports on data collected over 6 months (July to December, 2008). Quantitative data include student and teacher pre- and post project surveys collected as part of the evaluation of the project. Qualitative data consisted of teacher and student interviews at the beginning and end of the project. While the students were engaged in the science activities they were observed by university staff and/or teachers involved in evaluating the project. These observations were recorded as field notes or on videotape depending on the preference of participants. Specific permission was sought from both teachers and students for all observations and interviews to be included as research.

Data analysis

Analysis was a multi-staged process (Burns, 1994; Kumar, 1996; Miles & Huberman, 1994) that allowed cross interrogation of both qualitative and quantitative data to determine the basis of changed views with regard to the study of science at school and university and possible career paths.

Kumar's (1996) four stage model was adapted to accommodate the data that was collected in this study. After the data was collected it was read and loosely placed in categories that were revealed as the data were viewed and reviewed. The editing process allowed separation of unusable data such as non-serious efforts, incomplete or blank questionnaires. This was followed by the coding of the data from which summaries were developed. These summaries contained a brief outline of the data, possible theme headings and quotes that would likely be incorporated into the thesis at a later date. During the analysis step the data was read superficially in the first instance to gain a holistic view. This was followed by several deeper readings where 'like' material was physically grouped and where emerging themes were identified and refined. The final step was to assess the match or mismatch with the literature.

Findings and Discussion

The students selected for this program already had a positive attitude to the study science as they viewed science as 'fun', their favorite subject' or 'interesting'. They love the practical work and all students thought that science would be the focus of their study at university in terms of their aspirations to study, medicine, engineering, dentistry or human movement. All would be ranked in the top 5% of their cohort. While the researchers requested disinterested able students to see if they could be "turned onto' science the teachers saw the involvement in the program as an opportunity to reward their hard working science students.

Presentations show student s enthusiasm and ability to learn

During the first day of sessions in the confocal facility the students expressed their concerns about the level of terminology used by the senior scientists. The students suggested that at some stages they understood about 20-50 percent of what was being said. Conversely, while feeling a little 'scared and intimidated', they thought the facility was 'cool, mind blowing and the equipment was great'.

At the end of the first day's sessions each team of students was required to report back to the whole group what they had learned and what their plans were for their experiment. They had listened to a talk by Mark Jones, had sessions with advisors on the confocal microscope and were informed about the cells and chemicals they would be using. In during these sessions the teachers and the advisors were the go-betweens. The advisors deconstructed complex concepts for the teachers who then interpreted the same concepts for the students at an appropriate level.

The students were quite nervous about doing talking in front of the group and were concerned about their limited knowledge and comprehension of they had done, seen and heard. In this first instance the students had to be coached and terms interpreted for them by their teachers. At this early stage they demonstrated that they had very limited knowledge about cells, the organelles that are found in a cell and their functions. They had some understanding of mitosis. In some cases the information they shared was incorrect and the pronunciation of the names of the chemicals and cells was stilted. Others read off notes not really knowing what they were talking about.

The students' talks demonstrated to the Mark and the advisors how limited their understanding and knowledge was and provided a base for discussions on what was needed to provide more support in developing an understanding of the complex concepts they would be exploring. In a debrief after the first session it was apparent that Mark had overestimated the prior knowledge of the students and that any further lectures would need to be modified both in the use of technical terms, the depth of concepts covered and the analogies used. For example Mark had referred to the length of their experimental write ups as not being as long as "War and Peace". I quickly had to jump in and refer to "Harry Potter and the Half Blood Prince" as they had not heard of the first book.

What became one indicator of the success of the program was the change in the ability of the students to present their findings. They were given the opportunity to present their findings to the group after each session. After only four days at the facility a final presentation was given to 100 scientists from Merck, Sharp and Dohme. The students knew they would be presenting to an authentic audience and I believe that this was a strong motivator for them to get it right because they “didn’t want to make fools” of themselves. Their presentations were very impressive. They used no notes, spoke clearly and did not stumble over terminology. They were also able to answer questions put to them by the audience. The positive comments from the audience included those of the managing director who wished that he had been such a confident speaker at their age. Many staff comments on how informative the student’ presentations were and how much they had learned.

The learning was not only in one direction from experts to the students.

At the beginning of the program the four advisors were somewhat sceptical about what could be achieved in four sessions. As they explained that they had been working with the equipment for periods of 6-12 months and still felt that they were learning how to use such high level technology. However, where the students had shown concern over the terminology and concepts they were being introduced to there was no reticence in terms of using the equipment. The use of the microscope and the sophisticated equipment seemed like second nature to them after only a half hour session of instruction. Each student took their turn and it was not long before the other students became the tutors providing guidance to the new user. Field notes of observations and quotes taken from conversations revealed how impressed and surprised the advisors were at the rate with which the secondary students were able to develop skills and confidence in using the equipment.

While it was noted that the students did experience significant difficulties with the scientific metalanguage, within two sessions there are mutual exchanges of ideas through discussions and via email. One of the advisors commented on how much he had learned in the second session when one of his group members had shown him elements of powerpoint that he was not previously aware of. During the program the direction of the learning shifted from one way from the expert through the advisors and the teachers down to the students. By the end of the program the movement of learning was returning back from the students and the teacher directly to the advisors and the experts. The students were performing experiments and analysing their data and were then able to supply new knowledge that could be used by the expert and the funding company.

It was not only the students who demonstrated a growth in knowledge. The teachers had actively participated in the sessions with their students and commented on how science had changed since their time at university. On many occasions the field notes refer to the curiosity shown by the teachers who later commented on how they would use what they had learnt in many of their classes. The experience was restoring their love of science and reigniting their interest. One of the unexpected outcomes of this project is the nature of the relationships formed between the teachers and their secondary students. It became apparent very early in the program that the teachers saw themselves as learners as well as students supporters. The teachers engaged in learning the skills and content of the program as enthusiastically as the students while supporting the learning of their students.

The value of the experience

An initial concern of the teachers was that the students would lose four days of school and they questioned the affect that this would have on the other subjects studied by the students as well as their own classes. To this end both students and teachers agreed that the sacrifice had been worth it. As an enrichment program the teachers were able to see the value for the students but more importantly they were able to see its value from a personal and professional perspective. Twelve months on one of the teachers reports that while the science may have faded the experience has not. Several of the students are in school leadership positions that may not have been considered as an option before. Many of the students in the Discover Science@UWS program have been reported to have sought other opportunities outside of school to provide development of skill and knowledge not usually available at school.

The students valued the experience because they were very aware of the unique opportunity they had been presented with in terms of working with scientists and on such cutting edge equipment. It made their parents proud that they had been selected for such an experience as well as endorsing their personal enjoyment in studying science. No matter why the student was participating in the program all of the students commented of the value it had been to them. They comments on their increased understanding of the concepts they were covering at school and how doing ‘real’ science with ‘real’ scientists made it more exciting and interesting. They were perceptive in realising that there was content that they had covered that would not be part of their HSC but commented that this only helped them to understand the concepts that they would be studying for year 12 biology and chemistry.

Of most interest was the comments made by the students that they had been very doubtful at the beginning of the program and how little they had understood in the first session. This was soon countered by their realisation that they could understand complex concepts, ask intelligent questions and be part of discussion on issues relating to the tasks they had been asked to perform. When they had the opportunity to present their findings to and have discussions with the executives from the industry partner, each student ‘held their own’ very well.

Improved student outcomes

The students were able to demonstrate learning far beyond the parameters of the secondary science syllabuses and not only in the understanding of science. During the weekly sessions students were able to become increasing engaged in discussions where their input evolved from question asking to supplying answers for each other, their teachers and their advisors. Their ability to be self sufficient in the use of the equipment in such a short time was an outstanding feature of the program. The posters they prepared (see below) demonstrate their knowledge of the concepts and the processes they had used. Having ownership of the unique experiment meant that they could only rely on each other and their research to develop a quality piece of work.

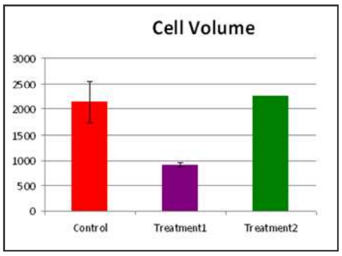
The students were well aware that Merck, Sharp and Dohme personnel would be present at their presentation. While adding to the pressure on them to produce well constructed presentations, it was apparent on the day that these students were able to reach the levels required to appear professional. Their posters were also well constructed and demonstrated a knowledge of the needs of their audience (Fernandez & Mitchell, 2002)

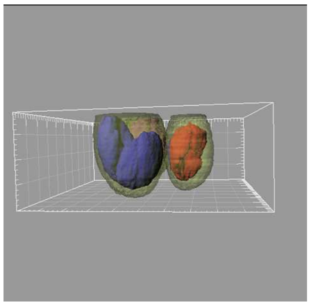
The Effects of Amiloride on Cultured B-Cells

Jody Tran, Phuong Tran, Theresa Tran, Filip Mirceski

Introduction

B cells can be observed under a unique microscope called the confocal microscope, which utilises different wavelengths of lasers to excite the molecules so they can be seen under the microscope. In order for the B cells to be viewed they need to be stained and in this instance Acridine Orange (AO) was used. Under the 488 laser the AO fluoresces DNA and RNA green and red respectively.





Method

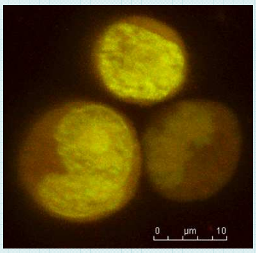
Three samples of L1210 B-cells were collected and placed on a slide. Four micrograms of AO was added to all three samples. The first sample had no Amiloride. The second sample had ten micro-grams of Amiloride. The third sample had one hundred micro-grams of Amiloride. All three samples were put under the confocal microscope one at a time and observed. Photomicrographs of all three samples were taken in a form of a Z-plane.

Discussion

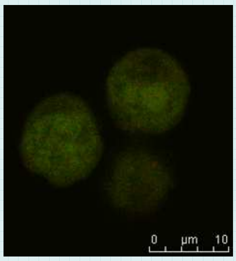
It was concluded that there may be a problem with the control as 10ug of Amiloride seems to have had more of an effect than 100ug of Amiloride. Therefore, the experiment can be improved through the repetition of the control to ensure it is free from error. Another error that could have occurred was during the collection of the data, where the Imaris program calculated two cells as one, so only the average volume of the three cells could be determined, but not the specific volume of each cell in each sample. This could have been avoided by selecting a group of cells which were not in contact together. Also, some cells had portions that were cut off, which could have caused errors in the experiment.

The results were abnormal as the control cells which contained no Amiloride had a similar volume to the Treatment 2 cells, but the treatment 1 cells had a much smaller volume. So, for better or more comprehensive results, we could have collected more data (more treatments) to try to obtain a pattern.

Results

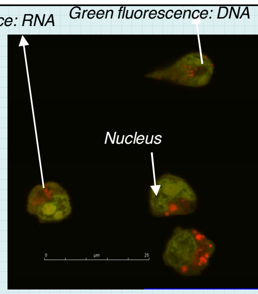


Control (4ug AO, No Amiloride)



Treatment 1 (4ug AO, 10ug Amiloride)

Red fluorescence: RNA *Green fluorescence: DNA*



Treatment 2 (4ug AO, 100ug Amiloride)

The Effect Of Efavirenz On White Blood Cells

Eleftheria Kambouraki, Nikola Andzic, Aydan Docwra & Zainab Albadawi

Introduction

The aim of conducting this experiment is to investigate the effect of Efavirenz on B cells lacking the Human Immunodeficiency Virus.

Efavirenz

Efavirenz is an antiretroviral drug used in the treatment of the Human Immunodeficiency Virus (HIV). The average adult human daily dosage of Efavirenz is 600mg.

Efavirenz is aimed to prevent HIV from replicating itself and forming its RNA to DNA in our cells.

B cells

B cells are a type of white blood cells in our immune system which are functioned to produce antibodies to combat antigens which affect our body system.

Materials/Method

- Before conducting the experiment a control was designed to distinguish the differences after Efavirenz was added on the cells.
- SYBR Green (stain) was added to the control.
- 0.1 ug/uL of Efavirenz was added onto the sample.
- Recorded results
- Next- B cells were stained with a 1/1000 concentration of SYBR Green 9.4 ug/uL (final concentration of 1/10000)
- Nile Red was added (1 ug/1mL) to stain the cell membrane

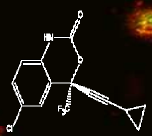
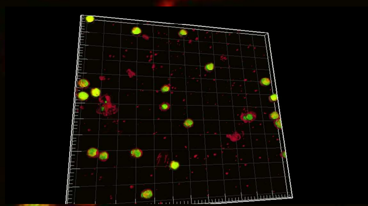


Fig 1. Molecule of Efavirenz



Results

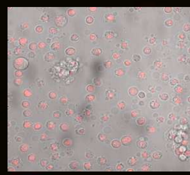


Fig 2. Cells first time Treated, 2 hours after treatment

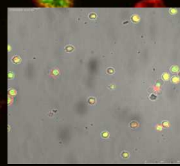


Fig 3. Cells Second Time Treated, 12 hours after treatment

Conclusion

In the first treatment (Fig.2), there was no obvious effect of Efavirenz on the white blood cells. The second treatment (Fig.3) had affected the cells due to the increased exposure to Efavirenz.
In conclusion it is shown that over exposure of Efavirenz has a negative effect on white blood cells.

Acknowledgements: Dr. Mark Jones, Ms N. Kumar, Sebastian Bowman

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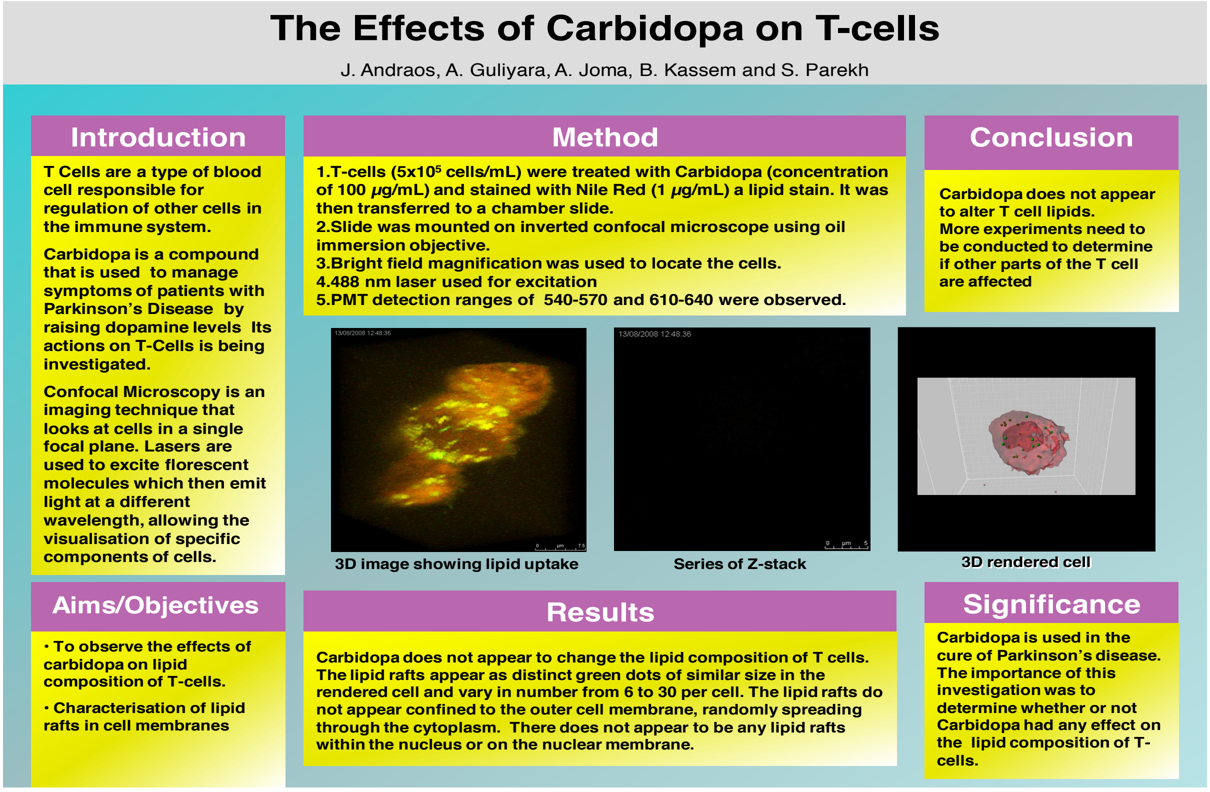

Attitudes towards the study of science

While the student participants had already been identified as interested in science for selection of this program their enthusiasm for further study in science has been compounded by their experience in the Discover Science @UWS program. They reported an excitement of being able to see the reality of science at university and talking to those who are engaged in science as a career. They were particularly interested in the presentations by the visiting industry partner executives who had outlined their journeys through university and working in scientific fields. The students became aware of the freedom to move within different areas of the scientific workforce. They suggested that it gave them another perspective in that they would not be limited to one type of science career and that science and business can combine well.

Science as a career

One student participant will not be studying science even though he is very interested in it as a possible career. His father and brothers are accountants and he expects to be an accountant. What this program has done for him however is made him realise that science is compatible with many other careers and that they can combine to provide a career path and good living. For the other students science is still in the forefront of their thinking in terms of a career but there has been a broadening of their horizons that are now not limited to medicine or vet science.

Positive learning experiences for all participants

The students' view of studying at university has been modified. Before the program they thought it daunting and that once you were enrolled in a course that you must stay in that course. They were not aware of the options for further study or the opportunities to work in small groups on research projects. All students responded positively to university as an option. At this stage the point was stressed to these students that working on the Confocal bio-imaging equipment was not a usual part of undergraduate study but a post graduate option. This information had them questioning their options of post graduate study and scholarships.

The academics are exhilarated by seeing their proposal come to life and the witness the learning for all the participants. While the process of the planning and development of the program was time consuming and often frustrating the end point was seen as well worth the effort. They have benefitted from being part of the process and will use this experience to expand their areas of research. Both academics are looking forward to presenting the data and findings at conferences and submitting papers for publication.

The teachers are excited by the changes that they see in their students but on a more personal basis reflect on their own growth. All three teachers expressed the view that they had incorporated much of their experience into their pedagogy. All communicated that they were now looking for more practical ways of bringing real science into their classroom. In particular they were able to bring the technology that they had experienced into the classroom and demonstrate it to their other classes. They valued the experience as a motivation tool not only for their students but for themselves. They suggested that they had often depended on the textbook for teaching and that they now realised that learning science from a textbook was not as engaging as hands-on authentic experiences such as in DS@UWS. At the very least their teaching will be peppered with examples of science and technology that has been experienced in this program.

Conclusion

While it is recognised that the students and teachers involved in this program were already motivated and enthusiastic about science, what became obvious was that setting a high bar lead to knowledge and understanding far deeper and broader than required in science syllabuses. These students were able synthesise and assimilate very complex concepts and use technology far outside their experiences in a short time frame. It could be suggested that they learned the science because of their interest and ease with the technology, not for the science alone.They were able to meet the challenges offered in the program and develop skills and knowledge about their own capacity to learn that will remain with them well after they have left formal schooling.

The need for educational reform in the teaching of science is well overdue and it becomes the responsibility of all stakeholders to ensure that the supply of enthusiastic and well prepared scientists remains in the forefront of planning. To this end the development of a successful engagement model for science students, university science units and industry that benefits from the employment of science graduates is imperative. The Discover Science @UWS begins this process.

It is time to recognise that our teachers need exposure to modern scientific practices as a form of professional and personal development and to inform their teaching practices.

While this program provided an opportunity for a small number of students to engage with scientists it also provided a framework for extending such opportunities within science and in other key learning areas. What is apparent is the role that industry must now play in the development of scientists for the future. As educators we need to collaborate with our industry partners to ensure not only a supply of scientists but scientists who are ready to take on the challenges of technology and future development.

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