Providing Graduate Attribute capstone experiences through In2science

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Contents

Executive Summary

In2science is a university-school mentoring program. RMIT has been involved since 2010, placing science, maths and engineering students into Victorian primary and secondary schools. They act as role models for students, mentor individuals and groups, work in parallel with classroom teachers and promote STEM subjects and careers.

Prior research into this program has indicated the significant benefits of involvement to the primary and secondary school sector. However this study has investigated how participation in the In2science program affects the development of the university students involved and how such development builds critical graduate attributes, especially those attributes designated as capstone by RMIT University.

The methodology employed was both quantitative and qualitative, with student volunteers surveyed before and after semester-long In2science school placements. Student responses were gauged on a Likert scale, indicating how frequently the graduate attributes were demonstrated during or after placements. In addition to the generic attributes survey, two select discipline cohorts, biotechnology and aerospace engineering, were targeted for measurement against specific discipline capstone attributes.

The results indicate overwhelmingly that participation in In2science improved the university students' understanding, development and achievement of in all key areas of the RMIT graduate attributes. This was also reflected in the discipline cohort of biotechnology. Limited responses in the discipline area of Aerospace did not permit conclusions to be drawn for this course. The areas of greatest improvements in graduate attributes were in communication with diverse groups and in social and cultural awareness.

Whilst there are limitations given the sample size and the self-rating response error margin, the results provide a useful platform for the extension of this program to satisfy capstone experience work for university students, especially in areas beyond existing learning and teaching opportunities.

The In2science Program

In2science is a university-schools mentoring program that commenced in Victoria in 2004. RMIT University has been involved since 2010, with the current program managed and funded by the College of Science, Engineering and Health.

The aims of the program are to increase enthusiasm for science and maths in the middle years of education (grades 5-10). It achieves this by placing current volunteer University students from STEM disciplines into local Victorian classrooms to interact with the students and staff and act as role models for STEM disciplines. The classroom staff use the university volunteers to provide advice, one on one mentoring, classroom assistance, laboratory or activity work, group work, lesson support or in some cases extension activities. Significant research on the In2science program's impact on improving the science experiences of primary and secondary school students has been conducted (Harris & Calma, 2009).

The aims of the program are to improve school student outcomes in STEM disciplines and to date little attention has been focussed upon the benefits to those university students volunteering in the program. At RMIT students receive a certificate of acknowledgement of their involvement and support with travel, mentor training and university timetables. There is currently no acknowledgement of any skills or graduate attributes that may be achieved through participation in this program at RMIT. Previous research has indicated that participation in In2science has several benefits for the university student volunteers, including a sense of satisfaction, improved communication skills and the opportunity to explore teaching, youth work and other STEM-focussed mentoring professions as potential careers.

Whilst further research has also investigated the benefits of the program to the university student mentors and identified enjoyment of placements and great satisfaction as outcomes gained from helping others. The same study found that a number of the university student mentors used the experience to investigate teaching as a career (Farrell & Harris, 2005). A more recent study found that university students appeared unaware of all the transferable skills they were developing and demonstrating throughout their placements (Cook, Fluke, Chang & Mann, 2012). Identifying these skills and relating them to the graduate attributes of university programs has not previously been undertaken.

Aims of this project

The aim of this study was to investigate how participation in the In2science program offered volunteers the opportunity to develop graduate attributes. Graduate attributes are the broad skills that a University expects that graduates will have acquired and be able to demonstrate to an appropriate level whatever their program of study. The goal of this project was to see if and how participation in the In2science program acted as a capstone experience for participating RMIT University students. By comparing the students' perceptions of their ability to demonstrate graduate attributes before and after participation in the In2science program, it was hoped the study would illuminate the relevance of the program to graduate attribute acquisition and provide insights into the ability of the In2science program to meet the needs of providing a capstone experience for both generic and discipline attributes for RMIT STEM discipline students.

Methodology

The study was conducted over semester 1 & 2 at RMIT University. Ethics clearance to collect data from all university student volunteers in In2science was sought and received. Three five-point Likert-style surveys were designed to assess RMIT graduate attributes in general and in two specific disciplines (Biotechnology and Aerospace Engineering). The graduate attributes were rephrased as statements of achievement and the participants asked to what extent they agreed with the statement. Each statement was designed and a small reference group of In2science staff, discipline staff and learning and teaching staff from the SEH College were consulted regarding the suitability and reliability of each statement as an accurate portrayal of the graduate attribute balanced against the student understanding of the attribute. An example of this conversion is shown below in table 1.

The statements were created as student surveys and were sent to all university student mentors who were participating in In2science for the first time in semester 1, 2013. Students were sent identical surveys both before and after their 10 week school placements. To maintain the anonymity of the participants in accordance with ethical clearance they were asked to generate a code so their responses to pre and post-placement surveys could be matched but responses could not identified with particular student mentors.

Aggregate data were considered for each question.

Only cases in which the same students correctly coded both pre and post surveys were included. This was done so individuals could be directly compared before and after placement. Of the correctly coded responses 15 mentors completed pre-placement surveys, and 10 returned post-placement surveys, resulting in a useful response rate of 66%

For ease of calculation, numerical values were assigned so each point on the Likert scale was equivalent to a numerical value.

— Not at all/never = 0

— Sometimes = 1

— Unsure = 2

— A lot of the time/mostly = 3

— Always = 4

Differences between pre and post-placement survey data were calculated by subtracting the numerical value from the pre-placement survey from the post-placement survey. Positive results indicated a self-rated improvement. Data was paired and then mean values of difference taken for all questions.

Table 1. Example of converting graduate attributes to Likert scale statement.

RMIT Generic Graduate Attribute "Lifelong Learner"	Statement	Responses
Take a benign attitude to error when being creative and innovative, recognising the usefulness of error in opening the possibility for new directions.	If I try something innovative and it doesn't work I feel my time has been wasted	• Not at all • Sometimes • Unsure • A lot of the time • Always

Results and Discussion

General Survey

For the generic RMIT University graduate attributes, correctly coded responses were collected for both pre and post-placement surveys for ten students in semester 1.

The RMIT graduate attributes span 5 key areas:

— Work readiness

— Global in outlook and competence

— Culturally and socially aware

— Environmentally aware and responsible

— Active and lifelong learners

Within each of these graduate attributes there are a number of sub-attributes describing such key areas. The following table represents the statements provided to the students describing these attributes and their responses to the statements both pre and post In2science placement.

Figure 1. In2science volunteer self-ratings against RMIT graduate attribute statements before and after placements for all students

As can be seen from figure 1, the students' perceptions of themselves as achieving the generic RMIT graduate attributes improved in all key identified areas. The one exception was the statement referring to engagement with RMIT's International networks. This was not expected to change as the In2science program has no international component or expectation. Interestingly the self-reported rating on engagement with international engagement dropped, perhaps as mentors understood what engagement really meant. Students however did rate their attributes of global in outlook and competence as still improving through the In2science program, by achieving gains in understanding different economic, cultural and social environments and being able to work to solve problems in diverse teams. These skills, whilst clearly attained in domestic environments, are still rated as achieved through In2science and seen by the students as improving even in non-global environments.

There are clear improvements across all main categories of graduate attributes. Significant improvements occurred in the students' perception of themselves as environmentally, culturally and socially aware graduates. Such improvements indicate that the In2science program has clear benefits in achieving generic graduate RMIT attributes. The evidence also indicates that the program may be used to provide a measurable capstone experience for RMIT students to achieve such attributes.

Whilst it is recognised that not all of these improvements can be attributed to In2science solely as students are also concurrently studying their academic courses which in turn may be also providing growth towards the generic attributes, further research is needed to understand the relationship between the two areas of learning. Greater explicit detail would enable better targeting of generic attributes in discipline studies and in the In2science program.

It is also worth noting that while there were significant improvements in most graduate attribute key areas, there were some areas beyond the scope of the In2science program. There was no stated improvement in English language proficiency over the duration of the placement. It may be that English language proficiency improves for students with English as a second language, but participation in In2science has no noticeable effect on native English speakers. Cohort data was not collected in this study so it is not possible to draw conclusions as to whether this is the case here or not.

The analysis of the data reveals areas of greatest gain in graduate attributes as being in students perception of themselves as understanding relationships between environmental, economic and social sustainability, the appraisal and critique of the social and economic effects of workplace and business activities on groups and individuals and the ability to work to solve problems in diverse teams through respectful communication and co-operation. Even in the lowest recorded improvement, students still showed gains in the ability to use technology competently, effectively and appropriately to carry out a range of tasks in their discipline.

The overall changes and students perceptions of improvements in graduate attributes are detailed in table 2 below.

Table 2. Summary of differences between self-ratings before and after In2science placements for all students.

Difference	Attribute Statement
1.38	*I understand the relationship between environmental, social and economic sustainability*
1.38	*I can appraise and critique the social and economic effects of workplace and business activities on groups and individuals*
1.00	*I can work to solve problems in diverse teams through respectful communication and cooperation*
0.88	*I respect the role of cultural difference and diversity in work and social contexts*
0.88	*I understand social justice*
0.88	*If I try something creative/innovative and it doesn't work I don't feel my time has been wasted*
0.75	*I can work with people of differing abilities in my discipline*
0.75	*I understand the social and cultural heritage of Aboriginal and Torres Strait islanders through active engagement with individuals and communities*
0.63	*I can use my communication skills to ensure a work task is accomplished effectively*
0.63	*I have skills that will contribute to personal and career satisfaction*
0.63	*I have skills in understanding and managing my work environment.*
0.63	*I have skills to suit different economic, cultural and social environments*
0.63	*I can use my environmental and sustainable literacy in a range of contexts*
0.63	*I understand equity and empathy and its importance in the workplace*
0.63	*I adapt my learning approach to suit different tasks*
0.50	*I have strategic planning skills*
0.50	*I critically reflect upon my personal attitudes, decisions and conduct*
0.50	*I am able to acquire and assess relevant information when set a task*
0.50	*I can apply my knowledge and skills in meaningful ways*
0.38	*I can show initiative to lead to a productive outcome in a work situation*
0.38	*I can take responsibility for critical decision-making to ensure sustainable outcomes*
0.38	*I can articulate and apply personal ethical actions in the workplace*
0.38	*I take an active, personal responsibility for my learning*
0.25	*I show initiative and self-motivation in relation to my learning*
0.25	*I critically reflect on my learning and its outcomes*
0.25	*I am committed to ongoing personal and career-related learning*
0.13	*My English language proficiency will allow me to perform effectively in the workplace*
0.13	*I have suitable problem solving skills to contribute effectively to my workplace/industry*
0.13	*I can use technology competently, effectively and appropriately to carry out a range of tasks in my discipline*
-0.25	*I have engaged with RMIT's international networks*

The students' perceptions of their learning and growth in these attributes identifies the pivotal role the In2science program can play in furthering attribute development in early year university students and providing consolidation capstone measurement and finishing experiences for students at the end of their studies. This is achieved through a cost-effective program that has two-way benefit for university students and school students. It also provides an efficient tool for university discipline and program leaders grappling with the provision of such capstone experiences across all generic attributes.

To measure the value of In2science as a capstone experience for particular discipline graduate attributes, as opposed to the generic RMIT graduate attributes, two discipline student cohorts were selected for further analysis. These disciplines were deliberately chosen for their differences in graduate attributes. The two disciplines were Biotechnology and Aerospace Engineering.

The number of responses able to be used as reliable data was limited by the response rate of biotechnology students. However the results do provide valuable information about the attainment of discipline specific graduate attributes by Biotechnology university students. The mean data is shown in figure 2 below.

The biggest improvement was in communicating with different social and cultural groups, which improved by 1.67 rating points. This was followed by communicating engineering ideas with the wider community and appreciating the issues and debates in biotechnology.

The only area that did not show an improved self-rating was in intellectual curiosity, which was rated highly pre-placement by all mentors. This may be reflective of the cohort in biotechnology prior to enrolment at university, or may be an indication of achievement of this attribute through the actual biotechnology course. Further research can identify this relationship, but as a measurement, it is clear that the In2science program can provide a range of attributes not delivered or attained in the biotechnology program. This data can be extremely useful in mapping potential program architecture for biotechnology students to acquire all generic and discipline specific attributes.

Figure 2. In2science volunteer self-ratings against RMIT graduate attribute statements before and after placements for Biotechnology students.

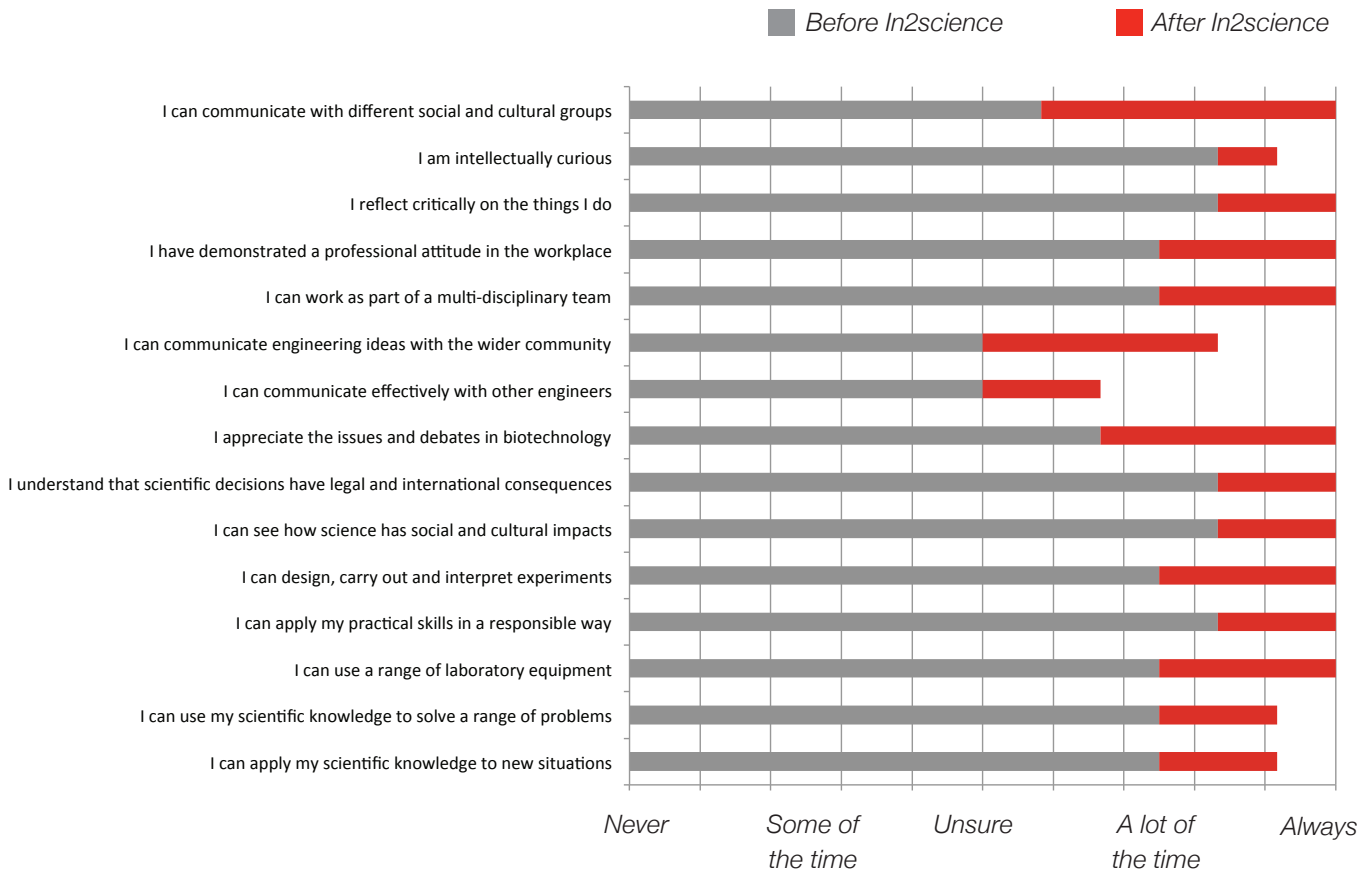

Table 3. Summary of differences between self-ratings before and after In2science placements for biotechnology students.

Difference	Attribute Statement
1.67	*I can communicate with different social and cultural groups*
1.33	*I can communicate engineering ideas with the wider community*
1.33	*I appreciate the issues and debates in biotechnology*
1.00	*I can use a range of laboratory equipment*
1.00	*I can design, carry out and interpret experiments*
1.00	*I can work as part of a multi-disciplinary team*
1.00	*I have demonstrated a professional attitude in the workplace*
0.67	*I can apply my scientific knowledge to new situations*
0.67	*I can use my scientific knowledge to solve a range of problems*
0.67	*I can apply my practical skills in a responsible way*
0.67	*I can see how science has social and cultural impacts*
0.67	*I understand that scientific decisions have legal and international consequences*
0.67	*I reflect critically on the things I do*
0.67	*I can communicate effectively with other engineers*
0.33	*I am intellectually curious*

Aerospace

The data available for measurement of aerospace engineering did not allow suitable analysis. Only one participant responded to the pre-placement survey and none to the post-placement survey, thus no data is available regarding the impact of involvement in In2science upon achieving aerospace engineering specific graduate attributes.

Comparisons of Paired Data

All In2science placements are unique with each student having a unique combination of school, class teacher and environment. Thus, while some key areas like communication skills will improve, it is not to be expected that all students will show impact in the same graduate attribute key areas. Some aspects, like engagement with Aboriginal groups and communities or diverse cultural groups, are not present in all placements however some individual mentors may have this opportunity. Therefore it is important to analyse the data for individual university student mentors to gain a more appropriate picture of individual gains in graduate attributes.

To understand variations in questions, paired data from pre- and post-placement surveys were considered for individual mentors, a selection of which is shown in figure 3.

Figure 3. In2science mentor responses to selected questions.

For example it is clear that for student number 1, the ability to work with people of differing abilities was not developed through In2science, nor was a capacity to understand the social and cultural heritage of Aboriginal and Torres Strait Islanders through any active engagement. The In2science placement for this student may have not afforded such opportunities. Without further analysis of the individual student's placements and the opportunities offered to them whilst on placement, it is difficult to draw conclusions from this data. But initial evidence suggests that the greatest gains again were in the ability to work in diverse teams through communication and co-operation. This is a key RMIT University graduate attribute and the correlation between volunteering in In2science and improving one's self-rating in this attribute is clear. What are not clear are the other contributing factors that may have caused this improvement. Further research is required to better understand this correlation.

If the In2science program is to be utilised as a tool for measurement and attainment of capstone experiences, then some care may be required to ensure that all students have opportunities through placements to achieve and develop such graduate attributes, This will be a fine balancing action as the purpose of In2science is primarily focussed upon primary and secondary students' needs, rather than those of the university students.

However, the paired data does indicate that for the over-whelming majority of university students significant gains were made in achievement of both generic and discipline specific RMIT graduate attributes.

Conclusions

The results indicate that participation in In2science improves attainment of graduate attributes for university students in all key areas of the RMIT graduate attributes:

— Work Readiness,

— Global in Outlook and Competence,

— Culturally and Socially Aware,

— Environmentally Aware and Responsible and

— Active and Lifelong Learners.

The most significant areas of improvement were in communication with diverse groups and social awareness. Though participation did not affect graduate competencies such as problem solving skills, use of technology or English language proficiency, participation did give university In2science students the opportunity to gain workplace experience, develop skills such as communication and gain a social and cultural awareness beyond what is possible through academic study alone.

This research indicates that the In2science program is an invaluable tool for the development and attainment of RMIT Graduate attributes, both in generic and discipline specific areas. As such the In2science program provides benefits to the university students, RMIT University and Victorian schools, beyond its primary aims and can be a vital avenue for the measurement and achievement of graduate skills in a capstone experience for all university programs in the College of Science, Engineering and Health.

References

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