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UQ STEM Evaluation project

2016 SSP Program-by-program Analysis and Recommendations

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Research Team

Assoc Prof Will Rifkin, Chair in Social Performance, Centre for Coal Seam Gas (CCSG)/CSRM
Dr Kathy Witt, Postdoctoral Research Fellow, UQ Centre for Social Responsibility in Mining (CSRM)
Dr Lisa Kelly, Research Officer, CSRM

Contributions in previous years by:

Bernadetta Devi, Research Manager, CSRM
Joni Parmenter, Research Officer, CSRM
Phil Clark, Research Officer, CSRM
Moira Arthy, Senior Consultant, Aurecon
Felix Delhomme, Research Analyst, CSRM
Nikki Kuper, Research Analyst, CCSG
Kylie May, Research Analyst, CSRM
Cecilia Reategui Olguin, Research Analyst, CSRM

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Details

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1.0	W Rifkin	30 September 2016	Original draft
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Executive Summary

STEM enrichment programs for schools in the Darling Downs Southwest Region have been supported by the SSP (STEM Schools Partnership), which for 2016 is sponsored by the CSG industry proponents, Arrow Energy and QGC/Shell, and coordinated by the Queensland Department of Education and Training. To inform decisions about program support, the evaluation strategy formulated in 2014 by a team from the University of Queensland (UQ) was again applied to STEM enrichment programs in 2016.

Focus for each year level - A key finding incorporated into this framework was identification of areas of emphasis needed in a STEM enrichment program to suit each year level of school. In other words, the international literature on STEM enrichment programs suggests that, in the lower years, efforts should focus on building interest and enthusiasm of students toward STEM, while programs aimed at higher years should have more emphasis on career options. See section 6 of this report for the table summarizing these aims.

Multiple data sources & improved survey - UQ's implementation of this evaluation strategy for 2016 involved interviews, student surveys, and an observation by a CSG industry staff member (a former teacher) of program activities. The results of this evaluation process are summarised in this report. The student surveys employed in 2015 provided equivocal results. That led to a significant change in the survey format as some of the previous survey's questions were seen as too abstract for the students. The new format survey has revealed a positive shift in the vocabulary that students see as characteristic of 'science', comparing 'before' to 'after' the Wonder of Science (WoS) program. So, our measuring instruments appear to be improving, and the WoS program now seems to be registering a positive impact according to survey results.

Wonder of Science and Try Trades - For 2016, only two of the five programs offered previously were supported – Wonder of Science and Try Trades. The Wonder of Science program engages students from years 5 to 9 in a research project for their science studies. Students are supported in these projects by Young Science Ambassadors, university students who visit their school on two occasions to help foster a feeling of connection with the 'wonder and excitement of science'. The program features two regional student conferences, where student representatives present and showcase their projects and attend workshops.

The Try Trades program provides students in years 9 and 10 with an opportunity to experience a different trade one day each week for 10 weeks via structured workplace visits. Sixty-one students participated in the third semester of 2016, from Chinchilla, Miles, Dalby and Tara. We understand that this pre-trade vocational training is supplemented by a week-long camp and work placement and apprenticeship opportunities.

Wonder of Science: appropriate focus - The Wonder of Science program appears to meet the international standards using the UQ chart of year-level targets. The program seems to continue to address a gap in the STEM arena for the region by engaging and motivating students and their teachers. It also enables them to connect with the university student ambassadors, with students at other schools (through the conference where students present on their projects), and with local businesses and communities. Feedback from teachers, principals, and students remains positive.

Try Trades: hands on - Try Trades appears to continue to be the sort of intensive experience that leads to a 'career-defining' or 'career-confirming' experience for the students involved. It provides hands-on, real world experiences for students interested in trades, helping to clarify which trade or trades resonate most for them. Students receive a kit of tools worth $1,000 to help set them up for a future career in a trade. Results of the 'post' Try Trades survey indicate that the program is well received by participants. A concern

raised during the UQ evaluation in 2015 was whether Try Trades was sufficiently tied to the curriculum or reinforced in classroom learning outside the one-day-a-week x 10 weeks experience. Student survey responses do not articulate such links, but they do indicate that Try Trades has influenced the students' choice of what to study, for 32 out of the 45 students surveyed.

Teacher PD - The UQ team were not assessing the teacher professional development (PD) aspects of the SSP. Materials to enable assessment of teacher professional development were provided to the Wonder of Science program facilitator, Robyn Bull, at the request of Jane Roberts of QGC. No feedback was received concerning the use or relevance of those materials. Interviews of teachers and principals revealed an ongoing desire for teacher PD in the STEM area and in the information technology area.

STEM Enrolments - The UQ analysis also considered trends in STEM enrolments and NAPLAN results. The aspiration is to identify whether the STEM programs sponsored might be seen as contributing to any upward trend in STEM enrolments or achievements in numeracy (NAPLAN assesses numeracy but not science). It was noted in UQ's 2015 evaluation that changes in STEM attitudes and enrolments tend to be most noticeable in response to school-wide initiatives, rather than in response to a single program. Additionally, STEM enrichment programs are recognised as a way to retain the STEM interest of students rather than to convert students into fans of science. Figures on enrolment in STEM-related subjects were analysed for two schools. Tara Shire State College represents a high school in a smaller town, and Dalby State High School represents a high school in a larger town. Analysis of the schools and changes in the surrounding communities (particularly migration) reveal no clear cause of shifts in STEM enrolments.

Contextual influences - In seeking to identify any aggregate trends, one has to be aware of significant changes in the size and make up of the student population in the Darling Downs, where variations in some schools can be more pronounced than in others. For example, enrolment at Chinchilla State High School climbed 25% in two years, which is partly attributable to a shift of year 7 students into high schools and partly attributed to an influx of low-income families into houses left empty following the CSG construction boom. Coal seam gas development stimulated significant movement of individuals and families within the region (e.g., to escape rising rents in 2011-2013), into the region for resource industry jobs, and out of the region (e.g., selling up at a good price during the CSG construction boom). Principals have noted a 'lack of continuity' due to students' families coming and going. For example, UQ's statistics on the region are showing that in recent years there has been an influx of families receiving government payments arriving in Chinchilla and Roma. They are reportedly drawn by a dramatic decline in rents following the transition from CSG construction to operations. These factors are addressed in the UQ Annual Report on the region – available here.

Final draft - These factors and their implications were introduced in a previous, draft version of this report. This version fills gaps in the previous draft. Significantly, surveys from after the Try Trades program's completion have now been analysed, as they were received by UQ in late October and early November 2016. This version of the report addresses the before/after data on Try Trades. Recommendations offered earlier and information provided by e-mail are still relevant. Also included is a brief expansion on contextual factors and general trends in the region – as well as opportunities - that may affect student interest in STEM areas. This sort of contextual information can help to explain trend data on NAPLAN test results for numeracy from two sample schools, which are included in this report.

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1 Introduction

The STEM enrichment programs for schools in the Darling Downs South West Region, supported by the SSP effort of CSG industry proponents, Arrow Energy and QGC/Shell, are undergoing consideration for 'renewal' of support for the 2017 school year. To inform that decision, an evaluation strategy formulated in 2014 by a team from the University of Queensland was applied to the STEM programs - Wonder of Science and Try Trades - in 2016. UQ's evaluation strategy involved interviews, surveys, and observation directed at program activities and the students, teachers, and principals.

An overview of findings is provided in this report. It begins with a summary of insights and recommendations in relation to each program. Then, data on each program are summarised.

A. Wonder of Science

B. Try Trades

C. Teacher professional development in STEM – comments by principals/lead teachers.

2 Program – Wonder of Science

Years 5, 6, 7, 8, and 9

Student projects were designed to embed STEM into the curriculum. A university science ambassador visited twice during semester. Two student conferences were organised in the region.

Recommendation - +/-

The Wonder of Science (WoS) program continues to address a gap in the STEM arena for the region by engaging and motivating students, and their teachers, and enabling them to connect with the university student ambassadors and with students at other schools through the conference. Teacher, principal, and student feedback has been positive, with students and teachers engaging strongly in STEM education at the WoS regional student conferences in semester 2 (210 students, comprising 44 teams).

UQ received 43 matching before/after surveys (the same students, the same year and same schools both before and after WoS). These surveys, along with interviews of teachers and principals, suggest that WoS increases student enjoyment of science, their confidence in science, and their interest in STEM-related areas.

This data set was limited by the number of post-WoS survey responses, which were lower relative to the pre-WoS survey numbers (151). This decline in the number of returned surveys reflects the challenges in dealing with rural schools from a distance. In addition, it is important to note that the survey is attempting to pick up overall attitudinal changes that might be resulting from a small part of a student's school experience during the term. Further analysis of survey results can be conducted to identify possible areas of focus for future offerings of WoS.

The WoS program is reported to be well run – based on comments by teachers and the CSG industry staff member who in 2016 observed the program's conference. A total of 587 students participated in the WoS program in Term 2, 2016.[1] It is one of the least expensive programs on a cost-per-student basis, at

[1] Chinchilla cluster schools did not participate in WoS, instead they participated in the Science, Technology, Engineering, Arts and Mathematics (STEAM) project, sponsored by QGC/Shell and the Queensland Museum. School

$170/student (semester 2). It offers two missions – providing activity to help shift the STEM culture of a school and offering – via the conference – a possible 'career defining moment' for some students.

3 Program – Try Trades

Years 9 and 10

Develops a working understanding of careers in construction, manufacturing, and engineering industries. Provides hands-on practical and theoretical skills in trade areas. Students visit work sites one day a week over a 10-week period. Placement and apprenticeship opportunities follow.

Recommendation - +/-

For 2016, no information arose to contradict the assessment of Try Trades in 2015. It still appears to be an intensive experience that leads to a 'career-defining' or 'career-confirming' moment for the students involved. It provides hands-on, real world experiences for students interested in trades, helping to clarify which trade or trades resonate most for them.

It is reported to be well organised. However, there were some concerns about the timing this year in relation to school holidays. It is not clear the extent to which this program is tied to the curriculum or reinforced in classroom learning outside the one-day-a-week x 10 weeks experience. That said, 32 out of 45 students surveyed said after the program that it had influenced their choice of what to study in the future.

UQ surveyed 61 students, from the same cohort. Before- and after- surveys were received and analysed. For 45 survey responses, we have data from the same schools and before and after the program.

The data from 2015 suggested that Try Trades introduces some students to new career options and seems to expand or clarify career choices. The 2015 cohort seemed less strongly orientated toward science than the average picked up in other surveys, but they were strongly oriented toward STEM-based trades. In 2015, about 60-70% stated that they were neither confident nor interested in maths, which may have implications for their capabilities in the STEM-oriented trades.

The data for 2016 shows that nearly all student are strongly orientated toward STEM-related trades, as one might expect given that students are selected for this program based on their predispositions. Student attitudes toward science and maths were not surveyed this year, given the re-orientation needed in the survey. However, maths ability can be gleaned from results of NAPLAN tests in the area of numeracy, keeping in mind that school-wide averages are hard to interpret in the period after CSG construction ended, given the apparent influx of students from low-income families. Interviews and anecdotal information reinforce the NAPLAN numeracy data (from the MySchool website) – that maths abilities at least in some schools have dropped.

Try Trades remains a relatively expensive program to run on a per-student basis, costing $1,443 per student for the one-day/week x 10 weeks of activities. That is nearly nine times the cost per student for Wonder of Science. The cost might be justified in terms of the relationships built between schools and trade

issues precluded a further four schools from taking part in WoS in term 2. Roma and Injune students, previously a large cohort participating in WoS (~275 students in 2015), were also not part of the target cohort in 2016, reportedly due to a lack of funding. The number of small schools in the program this year has risen, while the overall number of secondary schools and students has decreased.

employers and the potential for a multi-year impact on students; that is, the 10 days of activity could solidify student commitment across 2-4 years of study and training.

4 Program – Teacher development

As with the 2015 STEM evaluation, the UQ team were not assessing the teacher professional development aspects of the SSP in 2016. However, we did receive input again during interviews that is relevant to the need for teacher PD in the STEM area, and this information is presented here.

Recommendation - +/-

Teacher professional development is one element highlighted in the 'program logic' matrix that the UQ team developed for this evaluation effort. It is seen as essential by the school principals and lead teachers interviewed. Such professional development, in their eyes, seems to require several elements:

1. Opportunities for staff to learn and build confidence in more advanced STEM areas;
2. Assistance for staff in how to deliver STEM, how to use the tools, and understand the goals and expectations of the programs to make them more effective;
3. Adequate IT and digital technology capability, support, infrastructure and resources in schools;
4. Providing sufficient avenues for highly engaged staff – or those likely to become highly engaged - to feel that their time in smaller country schools is worthwhile; do that by rewarding them through in- and out- of school training
5. Opportunities for staff to connect with teachers in other regions and collaborate with teachers of other subjects for integration of STEM skills across the curriculum;
6. Changing the mindset of staff – that STEM is not just a program, and it is not just relevant to science; it has broader applications and links to other courses and life generally.
7. Identifying STEM as involving a skill set to be used across all subjects, and providing more information on how to implement these skills more widely.

5 Data Summary

Specific analysis follows for the two STEM enrichment programs – Wonder of Science and Try Trades. It is on the basis of program design, interview data, survey results, any observation of program activities, and other data. The table for each program concludes with recommendations that confirm those that are made in the introduction. The information below has now been finalised with additional Try Trades data. It provides results and insights to the program sponsors to assist with decision-making on the future and direction of the STEM programs. The recommendations offered in sections 2, 3, and 4 above are repeated here in the context of the specific data.

Program – ***Wonder of Science***

Years 5, 6, 7, 8, and 9
Student projects were designed to embed STEM into the curriculum. A university science ambassador visited twice during semester. Two student conferences were organized in the region.

Fit with international standards – *UQ chart of year-level targets*

1. Stimulate interest - ✔
2. Enjoyable - ✔
3. Ties to curriculum - ✔
4. Informal learning & extracurricular - ✔
5. Build confidence - ✔
6. Aids making connections - ✔
7. Practical learning - ✔

Interview data

Good:

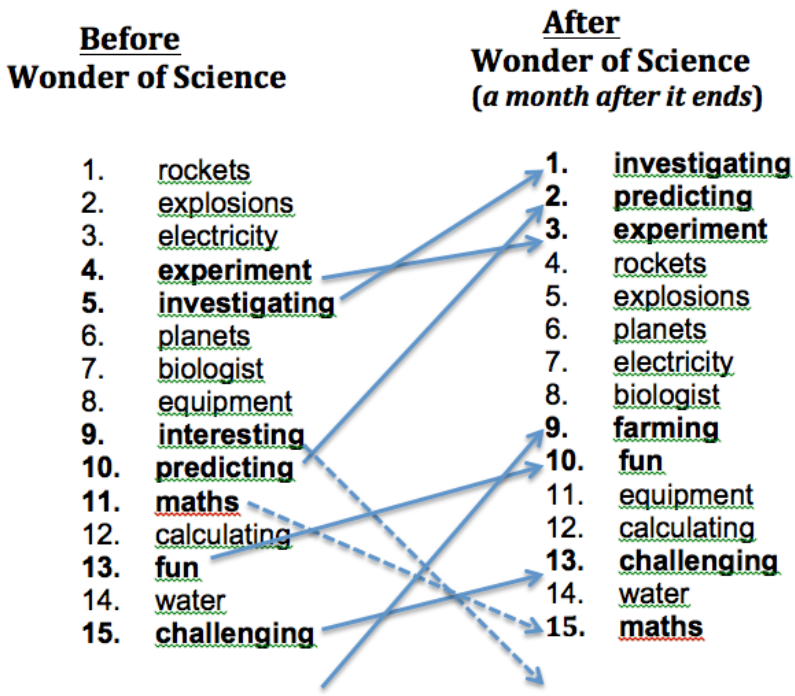
- Boosted student confidence & interest in STEM
- Fostered students' "real life" practical experience and engagement with STEM
- Builds strong STEM ties with curriculum
- Engaged "extended" students and challenged them further, and increased teacher awareness of their needs
- Engaged - but overloaded - teachers
- Supportive parents (once program was explained)
- Benefit from skilled staff (e.g., Robyn Bull), IT, and time
- Created opportunities to engage with ambassadors, competitions, and conferences
- Forged closer ties with local community and businesses where opportunities arise
- STEM is beginning to be viewed as part of other subjects and life, generally, rather than separate.

Could be better:

- Inclusion of STEM programs in school 4-year plans to facilitate budget and staff allocation
- More links to local community events, programs
- More links between primary and secondary

Program – *Wonder of Science*
• Increase levels of IT and staff capability in IT • Assistance in implementing the tools and understanding goals/expectations • More 'hands on', practical activities • IT or STEM support for parents • Topics in agricultural industry and practice • Where students do not receive a place in a STEM enrichment program, they lose interest • Where students do not have good results in STEM, they need to be shown that they can still achieve in STEM areas • Build STEM foundations in very early years, from years P to 4 • Continue the relationship between the ambassadors and the cohorts beyond the end of the one term • Overcome student remoteness - opportunities to mentor/meet introduce students to real people with STEM careers (particularly women)
Survey data
Good: Students are characterizing science more in terms of processes (investigating, predicting, experiment) than in terms of the technologies (rockets, explosions, electricity). Additionally, the students after WoS are noting a greater connection between science and farming. See the ranking below of 'science' words identified by 43 students in years 5-8 in two schools where before and after surveys match up. Students were given 50 words where they were asked to circle the terms that they felt were most highly related to science. The survey was administered at the start of the WoS program and a month after the end of the WoS program (to gauge any lasting effect). An argument for attributing this shift in vocabulary to WoS is that it is the one common factor (that we know of) across year levels and between the two schools. All students surveyed participated in WoS, and their teachers were engaged with WoS. The shift in vocabulary cannot be attributed to the Year 6 curriculum or the predilections of a particular teacher.

Program – *Wonder of Science*



The survey asked what students prefer to learn about, preferred careers, and what they liked or what could be better about the Wonder of Science.

Before the WoS, 53% of the students noted a preference for STEM-related areas to study, such as maths, science, animals, and how the body works. After the WoS, 60% of the students responded with STEM-related areas, with 'animals' again being a common response. In terms of preferred careers, before WoS, 59% of surveys indicated a preference for a STEM-related job. After WoS, 53% indicated the STEM preference, a drop of several percent (though statistical significance for such a small sample - 43 surveys - is not great).

One can conclude that the interest in studying STEM-related areas appears to be slightly greater than the interest in STEM-related careers. Note, that STEM enrichment programs for these early- to mid-years of schooling (years 5-7) are not meant to focus on career choices. The career choices reflect the aspirations of the students rather than necessarily well-planned career trajectories, with examples like – veterinarian or actress, farming or horse-rider, writing, astronaut, inventor, and teaching or working at a co-op.

What students liked most about Wonder of Science was mainly firing the rockets (in one school's responses) with working in teams with other people being mentioned often (in the other school's responses). General comments about the program included terms like – amazing, fun, good experience, cool, showed me new things, it helped to build self confidence, entertaining, and smart.

Could be better:

Only one student of the 43 survey respondents across the two schools opted to offer constructive criticism. They asked for, "More info on what we need for the presentation." All other comments were positive (though a few students offered no comments). It should be noted that this positive sentiment was evident a month after the final WoS activity, which is an endorsement for the lasting effect of the program.

Program – ***Wonder of Science***

The science words selected by students have the terms 'maths' and 'interesting' falling slightly in priority from before to after WoS. They were displaced by the terms 'farming', 'fun', and 'challenging'.

Observation data – *from observation sheets completed by a CSG industry staff member*

Observations from the student conference. Only a portion of students attend, having been selected by each school. Observation are by a CSG industry staff member from one company.

Good: (*comments by observer*)

- Students were engaged and asked lots of questions.
- Approximately 10 parents turned out.
- The event appeared to be very well organized.
- The young student ambassadors were really enthusiastic.
- Activities seemed strongly aligned with the key target factors for these year levels (5-8):
- Stimulated interest, enjoyable, tied to school curriculum, supported students' confidence, practical learning linked to daily life, challenged students, and were interactive and inquiry based.
- The students noted that they had learned all about the material in class.
- Building confidence in subject content and public speaking.
- Students questions were great and showed ability to analyse and question.
- The students appeared to be having fun and were enjoying learning. Development of a keen interest in STEM at this early stage is important.
- Success factors – YSA enthusiasm and support from sponsors.
- Overall – a great initiative that has students excited and interested in learning.

Could be better:

- More opportunity to make connections with professionals and topics outside school.

School/district data – *from NAPLAN via MySchool*

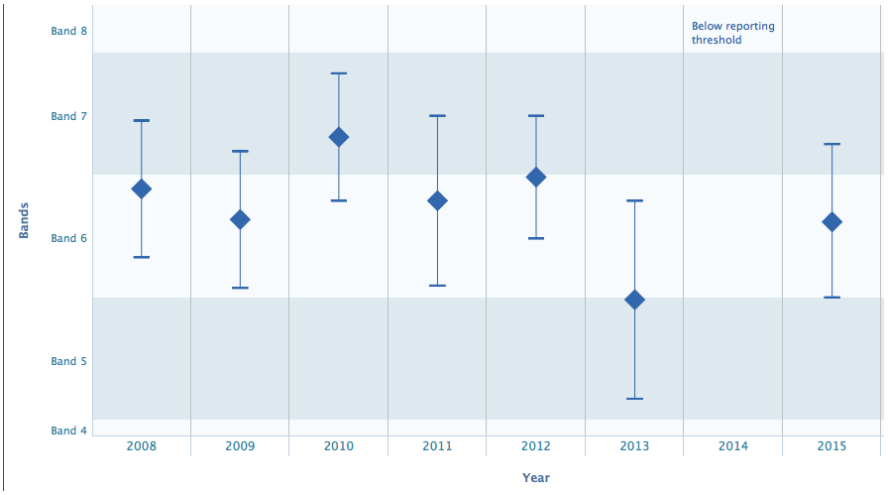
NAPLAN numeracy scores for the two surveyed schools (Tara Shire State College and Jandowae State School) seem to vary from year to year. The beginnings of an upward trend might be evident from 2014. However, many factors, such as the make-up of the student body or initiatives of the school principal or a particular teacher, can affect these figures.

See the charts on the next page.

Program – *Wonder of Science*

NAPLAN numeracy scores for Year 9 in Tara Shire State College from the MySchool website:

NAPLAN numeracy scores for Year 7 in Jandowae State School from the MySchool website:



Comments - *e.g., $/student*

587 students participated during the term.
120 students were at the Dalby conference, and 90 were at the Wandoan conference.
Cost for 2016 is $100,000.
Cost per student is $170/student for one term of activities, including a conference.
Cost per student - if just counting those at the conference who seem to be gaining the greatest benefit - is $476/student.

Recommendation - +/-

The Wonder of Science (WoS) program continues to address a gap in the STEM arena for the region by engaging and motivating students, and their teachers, and enabling them to connect with the university student ambassadors and with students at other schools through the conference. Teacher, principal, and student feedback has been positive, with students and teachers engaging strongly in STEM education at the WoS regional student conferences in semester 2 (210 students, comprising 44 teams).

UQ received 43 matching before/after surveys (the same students, the same year and same schools both before and after WoS). These surveys, along with interviews of teachers and principals, suggest that WoS

Program – *Wonder of Science*

increases student enjoyment of science, their confidence in science, and their interest in STEM-related areas.

This data set was limited by the number of post-WoS survey responses, which were lower relative to the pre-WoS survey numbers (151). This decline in the number of returned surveys reflects the challenges in dealing with rural schools from a distance. In addition, it is important to note that the survey is attempting to pick up overall attitudinal changes that might be resulting from a small part of a student's school experience during the term. Further analysis of survey results can be conducted to identify possible areas of focus for future offerings of WoS.

The WoS program is reported to be well run – based on comments by teachers and the CSG industry staff member who in 2016 observed the program's conference. A total of 587 students participated in the WoS program in Term 2, 2016.[2] It is one of the least expensive programs on a cost-per-student basis, at $170/student (semester 2). It offers two missions – providing activity to help shift the STEM culture of a school and offering – via the conference – a possible 'career defining moment' for some students.

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Program – *Try Trades*

Years 9 & 10
Develops a working understanding of careers in construction, manufacturing, and engineering industries. Exposure to hands-on practical and theoretical skills in trade areas. Students visit work sites. Possible placements or apprenticeships afterward.

Fit with international standards – *UQ chart of year-level targets*

2. Enjoyable - ✔
3. Ties to curriculum - ✔
4. Informal learning & extracurricular - ✔
5. Build confidence - ✔
6. Aids making connections - ✔
7. Practical learning - ✔

Interview data

Good: The interviews did not address Try Trades explicitly this year. However, the interviews of teachers and principals referred to aspects inherent in Try Trades. That includes stated desires for more connections with local businesses.

Could be better: A concern expressed during last year's UQ evaluation effort was about how well Try Trades aligned with the curriculum. There was not enough evidence gathered to suggest that alignment had been boosted, or that it had diminished.

Survey data

Good:

Students surveyed in relation to the Try Trades program provided responses about areas that they liked to learn about, preferred careers, and what they liked, or what could be better, about the Try Trades program.

About 70% of students said, before the Try Trades program, that they liked to learn about STEM-related areas. After Try Trades, the figure was similar, 69%.

Career choice shifted slightly from before to after Try Trades. Some specific trades – fitter, carpenter, farming, and auto – disappeared from the top ten list. Construction and engineer entered the top ten list afterward. Some new vague choices emerged afterward, as well – 'anything' and 'something'. Interviews might reveal what these selections suggest – potentially greater interest in careers generally, something that came out in responses to other survey questions.

Program – *Try Trades*

Top 10 'before' Try Trades – those crossed ~~out~~ did not make the top ten after Try Trades.

~~1. Fitter~~
2. Mechanic
3. Diesel
4. Boilermaker
5. Electrician
6. Welder
~~7. Carpenter~~
8. Builder
~~9. Farming~~
~~10. Auto~~

Top 10 'after' Try Trades, with those that are new to the list being included in **bold**.

1. Mechanic
2. Diesel
3. Boilermaker
4. Welding
5. **Anything**
6. Electrician
7. **Something**
8. **Construction**
9. **Engineer**
10. Army

Student comments about the program were overwhelmingly positive. Here is a set of 11 representative remarks from the 45 survey responses.

Stig welding was fun
It was good seeing all different trades and trying them
It is a very good to get an idea of what trades you want to do
Great program, cool stuff, learnt a lot of new and cool ideas
It was good to get an insight
It is a great opportunity
Great program to get insight into different trades
It was good to see what I could do after school
Do it every year please
Trip
It's really good and a good experience for people

The survey question on "What was good" about Try Trades yields the following word cloud.

Did Try Trades influence the students' choices of what to study? Most students responded on the survey with a 'yes': 22 'yes' and 12 'no'. Among female students who responded to the survey, there were 3 'yes'

Program – *Try Trades*
and 4 'no'. Of the students saying 'no', most showed a preference for a trade-related career anyway, except among the female respondents. That small group of female students providing 'no' responses had career aspirations outside the traditionally masculine trades that Try Trades covers. ***Could be better***: One student noted, "They should make it more intense." Another stated, "They should do it every year please." Another noted, "Too short." So, no consistent criticisms or advice emerged.
Observation data
Little comment on Try Trades was obtained this year. One principal commented that a staff member would be "lost for a day" to accompany the students to the nearby town centre and wait for them.
School/district data – *from NAPLAN via MySchool*
The number of students involved in Try Trades is so small that it is infeasible to identify general effects at a school level from this program.
Comments - *e.g., $/student*
61 students participated from 6 schools. Cost for 2016 = $88,000. Cost per student is $1,443/student for 10 days of activities.
Recommendation - +/-
Try Trades was characterized in 2015 as a highly regarded program. Our assessment for 2016 reflects results from analyzing student surveys, which indicate strong support from the student participants. Even those few who were not aiming for trade careers appeared to like the program. The small portion of female students in Try Trades were split in their aspirations, with only half of them aiming for trade careers. The survey responses do not provide evidence that students see Try Trades as a STEM-related program. Their interests, as indicated in the survey, are mainly STEM-related, nonetheless.

Program – Teacher professional development, generally

The UQ team were not assessing the teacher professional development aspects of the SSP. However, we did receive input during interviews that is relevant to the need for teacher PD in the STEM area, and this information is presented here.

Fit with international standards – *program logic matrix*

Teacher engagement and professional development is seen to bolster key inputs to achieving desire STEM outcomes for students. The UQ developed program logic matrix for the SSP specifies:

- Teachers have deep content knowledge as well as skills in teaching STEM subjects.
- Schools have appropriate resources (tools and equipment to support teaching STEM).

Interview data

Interview responses from teachers and principals that are related to teacher professional development were gathered in response to a question about the three top challenges in teaching about STEM topics. Responses were as follows:

- Adequate awareness, skills, capacity, and time of the teaching staff in relation to STEM and associated IT issues (if staff stay at the school long enough);
- Challenging the mindset among staff, students, and parents that for STEM these skills are not new, not just for science, and are relevant to any course and life generally;
- Building solid STEM foundations early in students (from prep level even);
- Planning and including an appropriate pedagogy for maths and science knowledge and skills in the four-year plan used in schools;
- Adequate level of resources (IT and staff), e.g., IT resources are better at high school, and therefore there is more student interest at high school level, and there is a need to create links with high schools for this reason;
- Balancing what is new and exciting in IT to students with what is enduring and useful elsewhere (e.g., in cities);
- Building links with the community, business and a town's history by encouraging them (e.g., local council and library) to notify schools of upcoming events, workshops and possible real world applications of STEM enrichment programs (especially demonstrating the possibilities for women with STEM in business).

These responses point to contributions that professional development could make in relation to IT capabilities, ways to foster changes in attitudes toward STEM, integration of STEM efforts across years and across town institutions.

Another interview question asked about effective ways to build students' interest and knowledge in STEM areas. Responses to this question also have implications for teacher professional development:

Program – Teacher professional development, generally

- More laptops, IT support, increased internet band width and internet technical support;
- Allocated time in the timetable for IT and STEM programs (limited student time out of hours);
- More 'hands on', practical activites, e.g., *RoboGal*;
- More continuity of student ambassadors in their continuing role of building their relationship with the school;
- Links across the curriculum (as is done in primary schools but is not done well in high school, where cross-course/staff coordination is more complex with specialised staff for each course).

These responses indicate a potential need for training in IT capability and ability to liaise within the school and to outside organisations, such as universities who can provide student ambassadors.

Survey data

Teachers were not surveyed, but they were interviewed, see above.

Observation data

Teacher PD was not observed and reported on by CSG industry representatives or any of the UQ team members.

School/district data – *from NAPLAN via MySchool*

Not applicable at this time unless a framework for assessing teacher PD is established. If a school sends several teachers for PD, it would be useful to look at school data to attempt to gauge the impact of that training.

Comments - *e.g., $/student*

The teachers and principals interviewed as part of this evaluation can be considered to be self-selected as being more engaged with STEM teaching and learning. It should come as no surprise, then, that they have a wealth of suggestions as to how to improve further the STEM opportunities for students in these rural schools.

Recommendation - +/-

Teacher professional development is one element highlighted in the 'program logic' matrix that the UQ team developed for this evaluation effort. It is seen as essential by the school principals and lead teachers interviewed. Such professional development seems to require several elements:

1. Opportunities for staff to learn and build confidence in more advanced STEM areas;
2. Assistance for staff in how to deliver STEM, how to use the tools, and understand the goals and expectations of the programs to make them more effective;

Program – Teacher professional development, generally

3. Adequate IT and digital technology capability, support, infrastructure and resources in schools;
4. Providing sufficient avenues for highly engaged staff – or those likely to become highly engaged - to feel that their time in smaller country schools is worthwhile; do that by rewarding them through in- and out- of school training
5. Opportunities for staff to connect with teachers in other regions and collaborate with teachers of other subjects for integration of STEM skills across the curriculum;
6. Changing the mindset of staff – that STEM is not just a program, and it is not just relevant to science; it has broader applications and links to other courses and life generally; and
7. Identifying STEM as involving a skill set to be used across all subjects, and providing more information on how to implement these skills more widely.

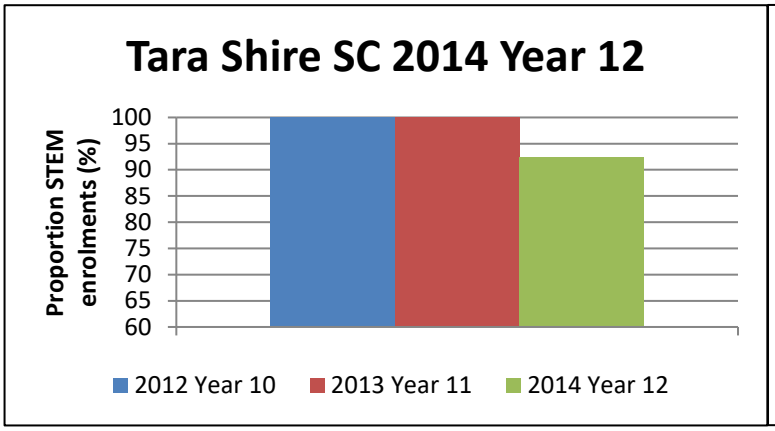
6 STEM enrichment program targets

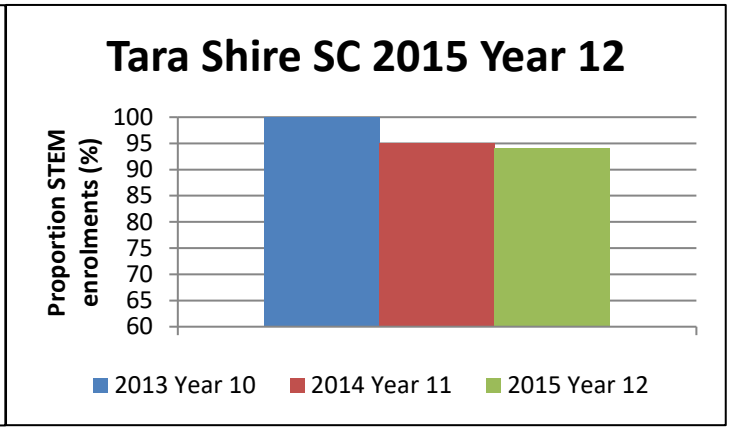
Key criteria suggested in the literature leading to successful outcomes of STEM enrichment programs:

Key Criteria	Year 5 - 6	Year 7 - 10	Year 11 - 12
Criteria 1: Activity's overall aim is to 'stimulate interest'	✓		
Criteria 2: Activities are enjoyable	✓	✓	✓
Criteria 3: Program is tied to school curriculum and timed to its schedule	✓	✓	✓
Criteria 4: Program includes informal learning and extra-curricular activities		✓	✓
Criteria 5: Program supports students' confidence and self-belief in doing well in STEM subjects		✓	✓
Criteria 6: Activities are aimed to help students 'make connections'		✓	
Criteria 7: Program features practical learning activities linked to daily life & local context		✓	
Criteria 8: Activities aim to challenge and prepare students for higher education and training			✓
Criteria 9: Activities challenge students through interactive enquiry & problem solving			✓

7 STEM Enrolment Trends

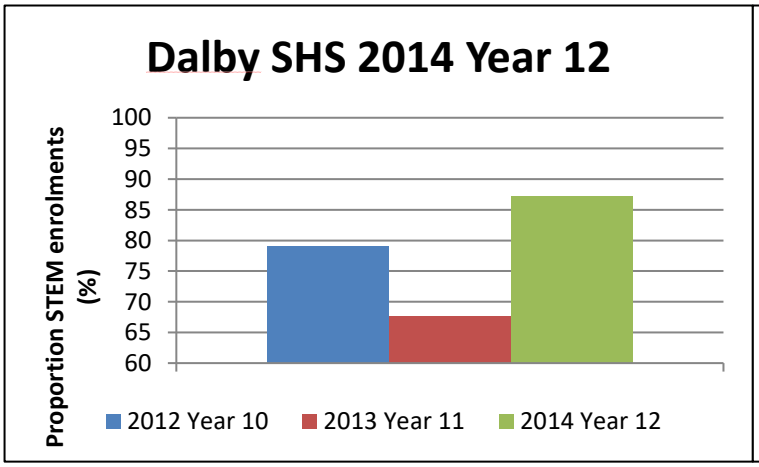
These figures suggest that the proportion of students who continue to take STEM-related subjects has been dropping in recent years at Tara Shire State College. The left-hand chart shows that 100% of students who finished in 2014 had enrolled in STEM subjects (a state requirement) in years 10 and 11. That figure dropped to 92% in their final year. The right-hand chart shows that a cohort who started a year later did not all stay in STEM for year 11, which resulted in a slightly lower proportion enrolling in their final year.

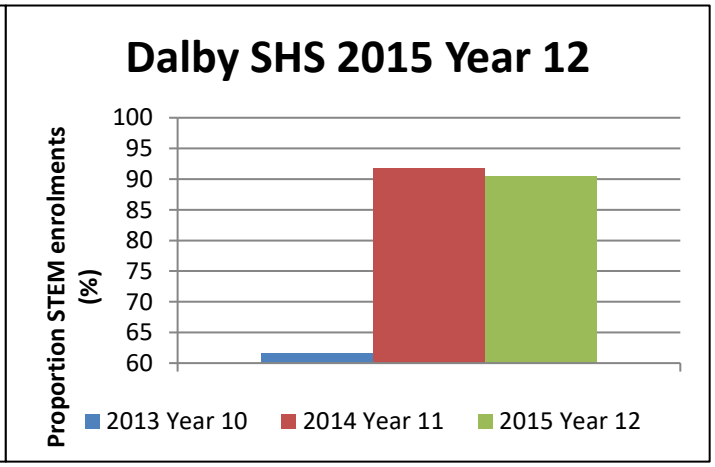




The charts for Dalby Senior High School show a different story. Though STEM is a requirement in years 10-12, the Dalby students seem to be taking advantage of options to avoid STEM subjects that Tara students do not have. That is, larger schools can have more non-STEM options at higher year levels, a factor that differentiates rural schools (with typically a higher proportion of students in STEM-related subjects) from urban schools (with typically a lower proportion of students in STEM).

The average STEM enrolment percentage for the cohort finishing Dalby SHS in 2014 is around 75% to 80%. The proportion enrolled in STEM subjects climbed in year 12 to 87%. That figure suggests that some students who were not interested in STEM might have migrated to other schools or left school. That is, the STEM-interested students stayed, and other students may have departed. The Dalby SHS cohort who finished in 2015 went from a lower proportion in STEM in year 10, 62%, to a much higher proportion in years 11 and 12, at around 90%. Again, one needs to ascertain the extent to which the rise was due to growing interest (perhaps attributable to Wonder of Science and/or other initiatives) or whether it reflects an outward flux of students not interested in STEM or an inward flux of students who are interested in STEM. Or, it could be some combination of these factors.





8 Graduate Destination Trends

There are notable changes in graduate destinations that correspond with the end of the CSG construction phase in 2013-2014. These changes include a decline in part-time employment and no evidence in 2014 of traineeships. There was a drop in the number of apprenticeships reported here from 2013 to 2014. There is also a drop in 2014 in the number of students heading for a bachelor degree. However, both the undergraduate and apprenticeship declines are proportional drops, as they accompany an overall drop from 250 survey respondents in 2013 to 180 respondents in 2014. It is unclear where the year students have gone post CSG construction. There may be a decline in students completing year 12 or a decline in students in the higher years in state schools (shifting to private schools). Figures for 2015 and beyond are likely to reflect trends in migration, with evidence and anecdote indicating that low-income families have been moving into available houses in Chinchilla and Roma. Implications for STEM may be a desire to cater to students in lower and middle years to stimulate interest in schooling, generally, as well as in STEM-related areas.