

Development and Validation of a Regional University's Model for Community and Industry Engagement

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***Abstract:** Participation by rural and remote area students has been identified as a critical element in increasing enrolments in higher education in Australia. This paper describes a research project to develop a model based on a regional university's investigation of a strategic alliance with the extractive energy industry to engage high schools in the local communities in engineering related activities, and ultimately to encourage participation by students in higher education. A key component of the model and adopted strategy was the design and conduct of engineering camps. This involved year 10 to 12 students in 2010-2011, from 13 regional high schools attending the university to work on real-life projects surrounding coal seam gas extraction. Students were also provided an opportunity to participate in site visits to experience life as an engineer in the energy industry. The desired outcomes of the model were: from the university's perspective to give students a taste of life as a student at university; from the students' perspective to raise awareness of issues surrounding the energy industry in their geographic area; and from the discipline perspective to demonstrate practical relevance of science, technology, engineering and mathematics (STEM) subjects. The planned outcomes would then help to engage the local communities through the students' schools, make students aware of opportunities for further study, demonstrate the ease with which they could transition from high school to university life, and thereby encourage high school students in these communities to aspire to a career in engineering and spatial science. The interactive model resulted in camps that have become an annual event due to their unquestionable success. The model has now been embraced by industry, and opportunities have also been identified to further develop the model through a strengthened high school engagement.*

Introduction

The national review of higher education (Bradley, Noonan, Nugent, & Scales, 2008) identified that Australia needs more well-qualified professionals, across a wide spectrum, to meet projected demand. To increase graduate numbers, and assuming graduation and retention rates remain relatively unchanged, the overall rates of participation in higher education must increase. One of the most feasible, ways of achieving this is to target the currently under represented groups for higher education participation. Bradley et al. (2008) identified several such groups, but most relevant to this paper are those from low socio-economic status groups from regional and remote areas. To improve participation, these students need to not only be given an opportunity, but they must also be encouraged to aspire to a university education. The issue then becomes how to generate aspiration and interest through an engagement model.

Each profession needs to look at its own performance in attracting new students, and their retention and progression once they are in the system. With respect to the engineering profession, Taylor (2008) identified that Australia needs significantly more engineering graduates in the workforce to satisfy the nation's predicted growth needs and to achieve targets for economic and social progress. From a systems approach, to provide increased numbers of engineering graduates from the higher education sector, student preferences must increase, accompanied by decreased leakage between

enrolment and graduation. It has been recognised that in Australia some of the problems of declining numbers in student preferences in engineering stem from the lack of engagement with science and technology in primary and secondary schools (Pearce, Flavell, & Dao-Cheng, 2010). One approach to help address declining enrolments in engineering and science is to raise the public image and awareness of those professions (Shi, 2010). Shi (2010) achieved this through carrying out promotional activities and special events including an engineering challenge for secondary school students.

This notion of encouraging high school students to aspire to an engineering university education by improving the community awareness is not new, but the question arises: how does a regional university achieve this? Loden and Biswas (2010) believe one way of fostering engagement between universities and high schools, and thereby improving public awareness, is through meaningful application of engineering and technical concepts into the school curriculum. They used the example of having high school students solve real-world problems such as those offered by Engineers Without Borders (for details refer to <http://www.ewb.org.au/>). The benefits of engaging high school students in engineering curriculum and related activities are well documented (for example see DeGrazia, Sullivan, Carlson, & Carlson, 2001; Loden & Biswas, 2010; Moskal et al., 2007), but still the number of school students undertaking Science, Technology, Engineering, and Mathematics (STEM) related studies continues to decline.

In recent years much research has been conducted to understand this international decline in students studying STEM subjects to gain insights into improving enrolments and diversity (Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). Often underrepresented groups such as indigenous students (Godfrey & King, 2010), females (Habashi, Graziano, Evangelou, & Ngambeki, 2009), first in family, or rural and remote students are identified as cohorts where participation can be increased to grow overall participation. In general, most researchers agree that to improve engineering enrolment and retention, and pursuit of STEM careers, methods are needed to enhance STEM performance at school level (for example Phalke, Biller, Lysecky, & Harris, 2009). A study in the USA (Habashi, et al., 2009) cited motivation and general personal interest as key aspects that are important in increasing interest in STEM related careers. It has also been identified that exposure to authentic engineering-related activities are critical in developing an engineering identity (Pierrakos, et al., 2009), and subsequent interest in engineering careers.

Unfortunately the barriers to encouraging high school student engagement with engineering activities are many. For example, schools have little time for activities outside the curriculum, universities are not always well equipped to deal with high school students, schools and parents/guardians do not always provide ready access to these students, and the students themselves may not be motivated when access is provided. Strategies, based on a proven model, are needed to overcome these barriers and this paper provides details on, and an evaluation of, the model and strategy developed by the Faculty of Engineering and Surveying (FoES) at the University of Southern Queensland (USQ).

Background

Southern Queensland has experienced substantial population growth in recent years placing a heavy demand on local infrastructure. The accompanying development activities and the expansion of the energy industry, particularly coal seam gas (CSG) and mining, in the Surat Basin have provided USQ with new opportunities in teaching and collaborative research. Much of this activity is in remote rural communities with significant levels of low socio-economic status families, often accompanied by no history of university education. USQ recognises the importance of undertaking community engagement activities within the Surat Basin and is well positioned geographically to provide flexible education and research solutions to help the local communities in the Surat Basin develop the skill base and infrastructure that will be necessary to grow new industries. These new industries will ultimately become the hallmark of sustainable community and local development that will serve those local communities long after the energy boom is over.

To value-add to regional development, USQ recognised that it required a sound understanding of local issues, detailed knowledge of the industries involved, sympathy for environmental and cultural matters, effective personal networks, and experience dealing with the local communities. To assist

with this understanding of the industries involved, over several years FoES developed close networks with members of the Queensland Minerals and Energy Academy (QMEA).

QMEA is a partnership between the Queensland Resources Council (QRC) and the Queensland Department of Education and Training. Supported by the Queensland Government, QMEA represents minerals and energy companies in Queensland through a range of project, programs and events involving high school students and teachers. QMEA has formal partnership arrangements in place with 27 state and independent Queensland schools to assist young people to start long term careers in the resources sector. These close ties with QMEA are strategically important to FoES given the activity in CSG and mining industries in the local area and a desire to add sustainable value to those local communities involved.

The aim of this paper is to investigate the efficacy of a strategic partnership formed between QMEA and FoES to foster community and industry engagement activities in a region experiencing growth in mining and energy activities and develop and validate an appropriate model for future use. The hypothesis is that undertaking projects offered through this partnership, involving relevant environmental issues in an engineering context, would effectively engage high school students.

Research Methodology and Project Description

Early in 2010 FoES undertook to investigate the use of a supporting system that was developed to expose high school students to authentic engineering activities. The proposed overall engagement model is summarised in Figure 1.

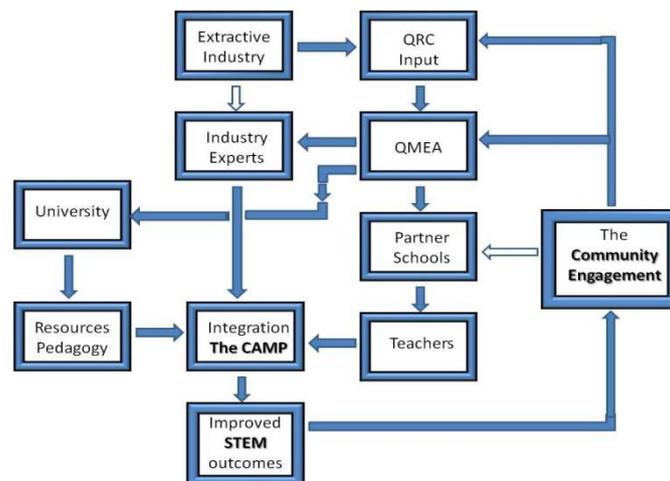


Figure 1: Engagement Model

Initially FoES made contact with staff from the QMEA with a view to establishing mutually beneficial community and industry engagement projects. A decision was made that FoES would host an engineering camp for high school students from QMEA partner schools. Many of the QMEA partner schools in the local region were located in rural communities as far west as Roma and this provided an ideal opportunity to engage with students and staff from these rural schools. Subsequently, in September 2010, FoES hosted 14 high school students for the inaugural QMEA/USQ Engineering Camp. All students were from regional areas and considered to fall into the regional and remote class identified in the introduction to this paper. The theme of the week-long camp revolved around CSG and the associated water quantity, quality and potential usage. The aim of the camp was to raise students' awareness of issues surrounding the CSG industry through the development of appropriate curricula and learning opportunities. Selected students, with aspirations of becoming engineers or spatial scientists, were given the opportunity to experience working life at CSG sites through undertaking site visits in the Surat Basin. Students, working in teams on the USQ campus, also participated in a work-based project to expose them to authentic engineering problems associated with the CSG industry. Key partners in the exercise, Santos, QGC, and Origin Energy provided professional staff to develop a mentor relationship with the students and to give the students an opportunity to network with professional engineers working in the CSG industry.

The students at the camp were allocated to four teams and were required to work on a real life problem associated with the CSG industry. The scenario presented to the teams was to investigate the problem of dealing with the disposal of water associated with CSG extraction. This was chosen because it would present sufficient technical scope, would be relevant to investigations at the site visits, could be easily expanded or contracted depending on student progress, and would also be a viable exercise in the case of inclement weather.

Each of the four student teams was asked to address this problem from one of the following perspectives: the Energy Company; adjacent land owners; the down stream Land Care Group; and a consultant engaged to advise the local Federal Member of Parliament. This scenario introduced technical issues such as quantity and quality of water, and potential uses of the water, as well as social issues such as environment risks in event of flooding, and cultural heritage concerns.

It wasn't all hard work for the students; they managed to have a good time as well. The site visits were welcome relief from researching their topic. There were also a range of social activities organised for students, which provided opportunities to informally strengthen the teams and helped students to form a positive opinion of university life in general, USQ and FoES in particular. Recreational activities included: a ten-pin bowling night, two DVD nights, one movie night, one trivia night, fatality goggles activity (which are used to simulate blood alcohol content levels of 0.05, 0.080 and 0.15), access to the recreational room at the residential college, and internet and email access on a daily basis for one hour if the students desired. On the last day of the camp, the student teams presented their work to a panel of professional judges from the partner organisations. Awards were presented at a formal dinner at the conclusion of the camp, and the Faculty also presented scholarships to students. The camp not only provided students with insights into the various aspects of engineering work in the CSG context, it also provided them with close insights into life as a student at USQ. All stakeholders considered the camp a huge success and it was agreed that this would become an annual event. At the time of writing, the 2011 camp had just been successfully completed.

One benefit as noted by (Hingston, Sher, Williams, & Dosen, 2010) is that this type of activity assists in transition from high school to university. The QMEA camp provided students from low socio-economic status groups (since the camp was fully funded and required no financial contribution from the students) and those from regional and remote areas an opportunity to experience working life in the energy sector and also to experience what life as a student at USQ might be like. Since it involved substantial promotion at the QMEA partner schools in the region, it also effectively achieved the critical function of community engagement. Logically then, this should help increase participation of these groups in higher education and thereby help address the issues identified by Bradley et al. (2008) and Taylor (2008).

Results

Of the 14 students who attended the camp in 2010, five were in year 12 and therefore eligible for entry to higher education in 2011. Two of these students commenced study with FoES in 2011 with the remaining three either not studying at USQ (in any Faculty) or taking a gap year. It is acknowledged that attendance at the camp may not be the sole reason for these two students commencing with FoES, however the authors believe that the camp was pivotal in the student selected USQ as their university. Although the initial numbers are too low to be definitive, and there is a need to track the other students longitudinally to see how many eventually enrol in FoES' programs, the 40% success rate is a qualitative indication of the programs' success.

Perhaps of greater interest is that two of the students who were in year 11 returned to the camp as year 12 students in 2011. One attended with his younger brother and there is anecdotal evidence to suggest that the presentation of scholarships and other exposure at school assemblies in late 2010 has had a positive impact on students wanting to attend the camp this year. Many schools, whose students attended the camp in 2010, are developing a culture where the attendees relate their positive experiences to their peers and thereby encourage others to aspire to attend the camp. The result has been attendance of 19 students and one teacher at the 2011 camp: a substantial increase from the 14 in 2010. It has not been established how attendance at the camp will influence students to take specific STEM related subjects in the remainder of their high school studies. However, the benefits of

exposing high schools students to practical engineering principles and thereby encouraging them to consider an engineering career is well established (for example Moskal, et al., 2007) and in this respect the camp is considered a success.

Evaluation and outcomes

On the morning of departure from the camp in 2010 the students were asked to individually complete a feedback report. The questions developed by QMEA staff in consultation with all stakeholders were designed to evaluate the effectiveness of the camp. Students were required to answer yes, no, or unsure to six focussed questions and also provide any additional comments. After collecting these, an informal focus group discussion was conducted by QMEA and USQ staff to assess the effect of the camp from the students' perspective and to discuss their open comments. It was encouraging to note that the formal feedback from students (refer to 2010 column in Table 1), and feedback from the company representatives, was overwhelmingly positive.

Table 1: Student Activity Review Feedback 2010

Question	2010			2011		
	Yes	No	Unsure	Yes	No	Unsure
Would you recommend this camp to others?	14			19		
Was the camp worthwhile?	14			19		
Did this camp meet your expectations?	12		2	19		
Did you learn something new?	14			19		
Has this camp influenced your career goals?	13		1	19		
Are you considering a career in the minerals and energy industry?	12		2	17	2	

Students were also provided space on the feedback form for open comments on aspects of the camp that worked well and not so well. Again, comments were overall very positive, however several elements were identified that allowed improvements to be made for the 2011 camp. The most popular comments involved the site tours and the fatality goggles. The most significant suggestion for improvement was to have less free time and more time working on their scenario: a clear indication of the quality of student who attended the camp!

The following student comments are indicative of the type of feedback received:

'The camp was an unforgettable experience and ... gave me an insight into the coal seam gas industry and reassured me of my decision of wanting to become an environmental engineer.' – Student comment

'It was thrilling and we all learnt a lot, but we had a great time too.' – Student comment

'I have never been to a camp outside of school and never would I have imagined that it would be so worthwhile.' – Student comment

Feedback from industry representative was equally encouraging. They were pleased with the authentic nature of the problem scenario, and commented that it was very accurate to the real industry situation and that it therefore prompted a lot of intelligent questions from the students. They felt there was a good progression from team building in the early stages of the camp through to productive problem solving and the final presentations, and they were impressed by the attitude, and general maturity of the participants.

One improvement identified was the need to make the scenario and the individual team daily outcomes more structured as opposed to the open-ended nature of the 2010 camp scenario. This is understandable since the students are used to this type of structured lesson plan format at their schools and the more open-ended problem-based scenario would seem to be more relevant to university study where the teams have more time to produce outcomes. The daily outcomes for the 2011 camp were more structured and this cascading of deliverables was a significant improvement. The change had the added advantage of putting a little more focussed time pressure on the teams and this brought out some increased competitive energy.

A further change in 2011 was that the staff facilitation team had a short meeting at the end of each day to compare notes and make any subtle adjustments as required. This allowed tailored improvements to occur and the amendments were seamless from the students' view point and did not detract from the important staff-student interface. Evidence of the effect of these changes may be inferred from formal

feedback from students as part of a similar exit report to that conducted in 2010 (refer to 2011 column in Table 1), and feedback from other stakeholders. Whilst the data is limited, indications are that the original hypothesis, that improved socialisation of current and relative environmental issues in an engineering context would engage students, is correct. The qualitative evidence from 2010 and 2011 indicates that the model developed has allowed the Faculty's strategy to succeed.

Future Directions

Based on the early research findings via the qualitative analysis of the 2010 and 2011 camps, USQ has adopted the model outlined earlier. The QMEA Engineering camp will continue as an annual event and by closing the feedback loop as indicated in the model, the conduct of this camp will continue to improve. Through this event FoES has been able to identify further opportunities to work with QMEA to enhance our position as an education provider in the local regional communities and encourage more students to undertake engineering and spatial science programs.

Some synergies have also been created. Hingston et al (2010) describe the benefits of a program to attract high school students to engineering and built environment involving the delivery, through online learning, of a first year university course to high achieving students while they are studying in high school. USQ has had a similar program since 2005. The USQ program, called 'Head Start', allows select high school students to study along side undergraduate students on-campus at Toowoomba, Springfield and Fraser Coast or via distance education from anywhere. Over 330 students have successfully completed the program, and since 2007 there have been 47 students from FoES complete Head Start courses. This program is now being actively promoted in QMEA partner schools and will be incorporated in the future model.

The partnership with QMEA has opened up significant opportunities for future activities such as the value-adding to QMEA partner schools with respect to the new national high school curriculum. This is a variation on the Head Start theme where coal seam gas units are introduced into the high schools and aligned with the national curriculum. FoES provides value-adding with respect to content and technical aspects and will, in the future, seek to enhance these high school units with laboratory activities through FoES remote access laboratory (RAL) system (for more details see Kist & Gibbings, 2010).

FoES is also in the process of investigating further high school curriculum alignment with its own courses. Loden and Biswas (2010) and Shi (2010) believe this can be an effective way of fostering university/high schools engagement and improving community awareness, both of which are critically important to increasing university participation in those regional areas. This curriculum alignment would see the content of one or more FoES introductory courses completely embedded into high school work units and at the same time aligned to the national high school curriculum. To assist in this process consideration will also be given to short term staff placements with companies operating in, and supporting, the regional energy industries and will require further development of the initial model.

Conclusion

This paper has described the development of an engagement model based on the establishment of a strategic partnership between a regional university and the energy sector to improve community and industry engagement in rural and remote areas. Two engineering camps for high school students have been successfully conducted and, although it is too early to make definitive statistical statements, the research outcomes indicate that the activity that it will encourage students, largely from remote areas, to aspire to a university education in engineering or spatial science. A qualitative study suggests that the initial project aims have been achieved and the underlying hypothesis, that undertaking authentic engineering projects involving topical environmental issues would engage high school students, is correct. Based on success of the model, the camp has become an annual event and this combined with planned future engagement strategies should ensure this university is doing its part in addressing the skills shortage in engineering and spatial science. The engagement model will be further refined through research based on outcomes and to incorporate new strategies identified through the partnership thus far.

References

- Bradley, D., Noonan, P., Nugent, H., & Scales, B. (2008). Review of Australian Higher Education Report: Final Report. (E. a. W. R. Department of Education, Trans.).
- DeGrazia, J., Sullivan, J., Carlson, L. E., & Carlson, D. W. (2001). A K-12/University Partnership: Creating Tomorrow's Engineers. *Journal of Engineering Education*, 90(4), 557-563.
- Godfrey, E., & King, R. (2010). *Scoping the opportunities to aid recruitment and retention of indigenous students in engineering*. Paper presented at the 2010 AaeE Conference, Sydney, Australia.
- Habashi, M. M., Graziano, W. G., Evangelou, D., & Ngambeki, I. (2009). *Teacher Influences on Child Interest in STEM Careers*. Paper presented at the 2009 Research in Engineering Education Symposium, Cairns, Queensland, Australia.
- Hingston, J., Sher, W., Williams, A., & Dosen, A. S. (2010). *A pathway from school to university - reaching down to build up* Paper presented at the 2010 AaeE Conference, Sydney, Australia.
- Kist, A. A., & Gibbings, P. D. (2010). *Inception and Management of Remote Access Laboratory Projects* Paper presented at the 2010 AaeE Conference, Sydney, Australia.
- Loden, D., & Biswas, W. (2010). *Enhancement of university curriculum and secondary school education through utilisation of sustainable engineering and appropriate technology workshops*. Paper presented at the 2010 AaeE Conference, Sydney, Australia.
- Moskal, B. M., Skokan, C., Kosbar, L., Dean, A., Westland, C., Barker, H., et al. (2007). K-12 Outreach: Identifying the Broader Impacts of Four Outreach Projects. *Journal of Engineering Education*, 96, 173-189.
- Pearce, A., Flavell, K., & Dao-Cheng, N. (2010). Scoping our Future - Addressing Australia's Engineering Skills Shortages: Australian National Engineering Taskforce.
- Phalke, A., Biller, M., Lysecky, S., & Harris, C. (2009). Non-expert construction of customized embedded systems to enhance STEM curricula. *ACM SIGBED Review*, 6(1), 1-11.
- Pierrakos, O., Beam, T. K., Constantz, J., Johri, A., & Anderson, R. (2009, 18-21 Oct. 2009). *On the development of a professional identity: engineering persists vs engineering switchers*. Paper presented at the Frontiers in Education Conference, 2009. FIE '09. 39th IEEE.
- Shi, J. (2010). *Promoting Engineering and Science via Community Based PBL Projects* Paper presented at the 2010 AaeE Conference, Sydney, Australia.
- Taylor, P. (2008). *Fixing Australia's engineering skills shortage is an urgent and shared responsibility*, *Engineers Australia media release, 29th January*. Retrieved from <http://www.engineersaustralia.org.au/da/index/getfile/id/5792>

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