Appointing Peer STEM Ambassadors in Regional High Schools

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Introduction

Through the Higher Education Participation and Partnership Program (HEPPP), the Australian Government encourages Australian universities to invest in initiatives that increases domestic students in higher education from families with low socioeconomic status (SES) backgrounds. Additionally, these initiatives should support these students throughout their studies to promote increased success. Many initiatives funded through HEPPP target high school students from schools in low SES areas with their outreach activities. Also, most initiatives have adopted the philosophy that interaction with a university could raise aspirations of students from low SES families to attend university.

Although HEPPP exists to increase participation in tertiary education of students from low SES backgrounds, it is essential to understand the reasons that students from these backgrounds are less likely to attend university in the first place. We approach this through the lens of Science, Technology, Engineering and Mathematics (STEM) to examine the potential of a HEPPP intervention to engage with low SES students and increase their aspirations to study a STEM course at university.

One of the reasons identified for the lack of low SES students choosing to participate in a STEM course in higher education is that they lack exposure to role-models from the STEM professions (Cooper et al., 2018). Parents and teachers of low SES students are frequently reported to have a lack of awareness of STEM careers, causing reduced participation of low SES students in STEM courses as parents and teachers are among the most influential factors on student subject choices (Hall et al., 2011).

STEM Ambassadors are posited to potentially fill the void of STEM role-models for low SES students (Gartland, 2015). While most of the research on Student Ambassadors focuses on cases where existing higher education students have been recruited to act as Ambassadors to school-age pupils, we aimed to establish Peer STEM Ambassadors and study their achievements as part of creating the CQUniversity Youth STEM Academy (CYSA). There is some evidence that Peer STEM Ambassadors may be more successful in engaging their classmates in STEM and that this may have beneficial effects for the Ambassadors themselves. A report by the Grattan Institute (2017) found that students are often more engaged with their learning when they have the opportunity to contribute to the design of their lessons. The CYSA program attempts to achieve student-lead curricular design by allowing the STEM Ambassadors to design an activity to run at their school. Collaboration with peers was encouraged to broaden the benefits of this approach to learning STEM following previous studies which reported positive impacts on Student Ambassadors' development and their peers (Pederson et al., 2012).

While Ambassadors have been suggested to raise the aspirations of students towards attending higher education (Gartland et al., 2015), more recent studies have suggested that the aspirations of low SES students are not substantially different from those of their higher SES peers (Gore et al., 2017; Archer et al., 2013). Rather, emphases should be given to nurturing the aspirations of low SES students over raising them. The CYSA program attempts to nurture the aspirations of year-nine Student Ambassadors with a year-long program that contains several opportunities for the Ambassadors to engage with scientists and lecturers from CQUniversity. Regular student and faculty interactions are proven to correlate with the academic success of college students (Anaya and Cole, 2001), and by this logic, increased interactions with a university should make attending higher education seem more achievable to low SES students.

Focusing on year nine

One of the most critical points in high school is the senior school subject selection. Students and their families must carefully weigh up choices based on interests, aptitudes and career aspirations. Chosen subjects must be within the student's capabilities and should facilitate a direct pathway into post-secondary endeavours. Mid-way through year ten, students must select from three mathematics subjects for senior school which count towards their Australian Tertiary Admission Rank.

Before 2019, General Mathematics, Mathematical Methods and Specialist Mathematics were called Mathematics A, B and C, respectively. Mathematical Methods is a prerequisite for most STEM higher education courses, while universities frequently recommend specialist Mathematics which must be studied concurrently with Mathematical Methods. All Australian undergraduate engineering courses commence with units that revise the Mathematical Methods and Specialist Mathematics syllabus as this knowledge is essential to progress through the technical units in these courses.

It follows that the Academy should engage with students at a time that is most likely to assist with senior subject selection and when students are likely to have the maturity to recognise the importance of developing excellent mathematics skills in senior school. Year nine was eventually chosen to retain as many students as possible in mainstream mathematics classes and to increase those eligible and motivated to study Mathematical Methods and Specialist Mathematics in senior school.

Also influencing the decision of a focus year for the Academy was the Australian Science and Mathematics Curriculum (ACARA, 2019). In science, 'Analysing patterns and trends in data, including describing relationships between variables and identifying inconsistencies' is taught in year nine, building on from 'Summarising data from investigations …' in year eight. In mathematics, 'Plotting linear relationships on the Cartesian plane with and without the use of digital technologies' is introduced in year eight. While in year nine, the expansion of linear relationships occurs in many ways, and the use of the Desmos App increases. Therefore, students in year nine should understand the concept of linear equations, how to construct them from data which they have observed, and how to solve associated problems. Year-nine students hence develop skillsets for solving many exciting and highly practical learning scenarios that emerge from practices in science and engineering. Finally, year-nine students are also reported to have successfully fulfilled mentor positions offered through other science outreach activities (Fletcher, 2016).

Appointing STEM Ambassadors at high schools

The six schools approached regarding the CYSA program all agreed to participate in 2019. They were all Queensland Government schools who serviced communities identified as having low SES determined by 2033.0.55.001 - Census of Population and Housing: Socio-Economic Indexes for Areas. The Index of Community Socio-Educational Advantage similarly rated these schools below the national medium of 1000 with indices ranging from 938 to 955. Furthermore, in all schools, at least 50% of students ranked in the bottom quartile of this index. There was also a significant variance in the size of schools included with total enrolments ranging from 135 to 1406. Classification of the schools by location was Inner Regional (5) and Outer Regional (1). Graduates outcomes for these schools included university attendance ranging from 16% to 23%, TAFE attendance was 15% to 26%, and 35% to 46% of graduates were full-time employed. These statistics collectively demonstrate that the CYSA program is working with many families whose circumstances present challenges with their children's education.

Through an agreement with school Principals, Heads of Department (HoD) Mathematics and mathematics teachers, the CYSA program was promoted in year-nine mathematics classes where students were encouraged to apply for a STEM Ambassador position by completing a Google application form. A bursary of $1000 to each successful applicant provided an incentive. Applicants added a link to a two-minute video on YouTube that they had prepared about what STEM meant to them and why they would be a good Ambassador for their school. Applicants also provided a statement of endorsement from a teacher, as well as a parent or guardian. Residential addresses were also disclosed to consider the SES classification of their family.

Students from all six schools made suitable applications, and all applicants were appointable. The selection process involved prioritising applicants that identified as being from a family with low SES background, then ranking based on their knowledge of STEM, and their confidence and ability to speak about STEM to fulfil the CYSA program objectives. The HoD (Mathematics) was also consulted to ensure the students selected would work effectively together. The Academy appointed twelve Ambassadors from the year-nine cohorts across the six high schools. All were from low SES families. 74% of applicants were low SES, 26% were medium SES, and no applicants were of high SES background.

The application process was not without some difficulties. Being the inaugural year of the CYSA program, there was some confusion among the teachers, students and parents. A letter to parents should be drafted from the Academy coordinators to avoid misinformation in the future. Some students had difficulty recording, uploading and sharing their application video. Problems were due to not being able to access suitable devices, a lack of video editing experience, poor internet connections at home and that their school had blocked access to YouTube. Some students and teachers commented this was their 'first YouTuber experience', which was a positive unintended outcome where students, teachers, and some parents developed new skills.

Some applicants presented compelling videos, but they were unsuccessful due to their family not being of low SES background. The SES levels are based on indexing by small geographic areas where a blend of family SES backgrounds could occur. Despite these shortcomings, there were no disputes or poor feedback received concerning the appointments made. However, this remains an awkward point where family SES backgrounds could potentially create disputes with this process.

The extent that family circumstances present challenges for children's education became apparent when organising the Ambassador Welcome and Information Evening. Three of the twelve Ambassadors were unable to attend as they were busy with family duties. These Ambassadors were also unable to attend via Zoom video conferencing due to unreliable internet connections or not having access to a suitable device. Through this experience, many school visits replaced the planned regular Ambassador group meetings. This approach detracted from broadening the experience of Ambassadors as they infrequently met their counterparts at other schools nor had the chance to reflect ideas among their unique group.

The role of STEM Ambassadors in the CYSA program

The Ambassadors had duties to assist with running the four principal activities offered by the CYSA program comprising the Practical Mathematics Excursion to CQUniversity, Ambassador-led school-based STEM activities, the STEM Student Conference and the research survey. Due to a very tight activity schedule, some Ambassadors were appointed just before their excursion, which prevented them from delivering a brief PowerPoint presentation that explained the activities and requirements to their peers. Fortunately, the

Academy coordinators found that students who did not receive this presentation were just as capable of completing the excursion. However, this task will remain as it formalises the appointment of STEM Ambassadors with the year-nine cohorts and leads to better progress with the next activity.

Ambassadors were also asked to design a STEM activity which they would run at their school for their peers shortly after the excursion. Some Principals requested the Academy coordinators to withhold providing ideas for these activities and force the Ambassadors to garner ideas from their teachers and peers and to imagine what they could learn at school. Unfortunately, Ambassadors from only a few schools came forward with reasonable ideas within a suitable timeframe. It became apparent that Ambassadors found it difficult to start these discussions without some initial ideas. Providing activity examples upfront is recommended in the future, but Ambassadors will be encouraged to try something new. In addition to designing these activities with assistance from teachers and the Academy coordinators, the Ambassadors were also asked to research what resources were required, send a resource list to the Academy coordinators (who would purchase items up to a total of $2000), run the activities, and record outcomes with photos and videos. The Ambassadors would not run the activity for all year-nine classes in some large schools. In these cases, not all classes completed the activities or teachers ran the activities for some classes on behalf of their Ambassadors.

The STEM Student Conference consists of sessions allocated to each school for Ambassadors to share the outcomes of their in-school STEM activities in a platform-style presentation. They were asked to encourage their peers, teachers and parents to register for the conference. Ambassadors were also asked to send a wish-list of whom they would love to meet from the STEM world, and the Academy coordinators would attempt to invite them as guest speakers. They were encouraged to think of anyone in Australia. At the time of this publication, the conference was still in planning.

The Research Services Division of Education Queensland had approved this project and the associated research survey for all six schools that had agreed to participate. Ambassadors at each school will give a brief message on a general assembly about completing the research survey and to generally encourage their peers to participate.

The Practical Mathematics Excursion

It was intended to offer the Practical Mathematics Excursion to all year nine students who were studying mainstream mathematics at the six schools. However, due to the high utilisation of suitable spaces at CQUniversity, the excursion could only be offered on specific days over five weeks commencing Monday, July 29. All classes from most schools completed the excursion, which resulted in the involvement of almost 500 students and over 30 teachers. Students took approximately 1 hour to complete their activity under the direction of the Academy coordinators who were assisted by undergraduate engineers. There were two activities offered based on demonstrating real-world application of measurement, data, ratios and linear equations using PASCO scientific equipment.

The first activity was measuring the displacement of the centre point on a model suspension bridge resulting from a vehicle carrying different masses. Students determined the maximum load that the bridge could service by extrapolating a linear equation derived from their data out to the displacement limit as specified in the Australian Standards. The second activity was slightly more complicated and was only completed by students in the highest stream mathematics classes. It involved measuring the internal forces in a model tower crane subjected to loads suspended at different points along the jib. Students also performed a tensile load test on a critical section of the tower crane to determine the ultimate strength of the structure. Linear equations were derived and extrapolated to calculate the maximum permissible serviceability loads at each point along the jib. Maximum loads and distance along the jib were also combined to create a linear equation which governed the safe operation of the crane.

Anecdotal feedback from the teachers was quite positive. They commented that these activities had combined much more of the mathematics and science curriculum than they had expected. Teachers also commented on how useful it was to see many elements of the curriculum combined in the one practical activity. Many students commented positively too. They were pleased to see that some complex engineering tasks can be solved using year-nine mathematics. A small number of students mentioned their desires to learn more mathematics so they could have a STEM career. Some also directly stated that they would study engineering or other STEM courses at university.

Another aim of the excursion was to give students an insight into studying at university. An engineering project studio provided a space fitted out for cross-campus collaborative learning which demonstrated many technologies that surprised the students. Approximately 90% of the students stated this was their first visit to this university. Also, at the end of each session, a similar number of students indicated that they found the excursion worthwhile.

Ambassador-led school-based STEM activities

Ambassadors were directed to several online resources to assist with deciding their in-school activity (Astrobiology Academy, 2019; NASA, 2019; National Wildlife Federation 2019; STEM-Works, 2019; Sterman, 2019). Planning of most activities occurred when an Academy coordinator met with Ambassadors and HoDs (mathematics and science) at their school. Although all Ambassadors had similar guidance, the in-school activities selected were quite different and comprised projectile motion, gyroscopes, exothermic reactions, virtual reality, and studying G-forces on students playing their favourite sport. All resources purchased by the Academy for these activities is gifted to the schools to continue supporting their STEM education programs.

Minimising the impact of the CYSA program on schools

As part of the research approval with Education Queensland, close management of the impact of the Academy activities on the school was necessary. The Academy coordinators organised for contracts of professional services with each school to pay for administrative staff to complete tasks including organising parental permission forms, assisting with running the in-school activities, assisting students to complete the research survey, and assisting the Academy coordinators with other tasks as necessary. Without these contracts, it would have been challenging to achieve critical tasks for the CYSA program.

Initial conclusions

Students in year nine can fulfil the responsibilities of STEM Ambassadors, but more frequent contact is needed to help them progress. It is too early to conclude if focusing on year nine assisted students to make an informed decision about mathematics subjects in year ten and senior school, but it is evident that students in this year possess mathematics aptitude and knowledge of scientific inquiry that facilitates practical learning and real-world demonstrations of their curriculum in STEM-related fields. The research survey will gather student and teacher feedback on the activities offered through the CYSA program, and anecdotal evidence shows that all teachers and most students found the excursion worthwhile. At the time of this publication, delivery was underway of the Ambassador-led school-based activities and the planning of the STEM student conference. Outcomes of these activities will be published separately.

It is also highly apparent that the CYSA program would not be successful without HEPPP funding and arrangements of contracts of professional services to assist schools to undertake the many critical administrative tasks.

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