WANAGO PROGRAM

EVALUATION REPORT

December, 2019

Prepared by Dr Damian Maher

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EXECUTIVE SUMMARY

This is the first year that the Wanago program has run. Overall, the program has been successful and is expanding. During this year there have been some changes as the staff has come to understand the possibilities and limitations associated with the program. Two of the three pilots have been successfully implemented this year. One of the pilots did not run as fully as anticipated due to circumstances outside of the university's control.

The program is expanding and will involve six classes next year, five at UTS in Engineering and one at South Eveleigh where students will undertake Software Design and Development in association with the Commonwealth Bank. Such an expansion will require careful consideration in the ways spaces, resources and personnel (staff and students) are utilised.

One aim of the program is to provide opportunities for students to undertake engineering studies where there is no qualified teacher in their school. This was successfully provided for students on the year 11 class this year.

The success of the program for the two classes from which data were collected has resulted in increased learning opportunities through the development of curriculum enrichment activities and projects facilitated by UTS academics and students as well as access to spaces and resources.

One of the aims of the program is to achieve 50% gender diversity in relation to school students attending the Wanago program. This diversity was not achieved at the beginning of the year but there has been greater female participation rate late this year.

A further aim of the program is to improve access for students from low socio-economic backgrounds. This was not evident. The majority of the schools involved in Wanago this year come from medium to high socio-economic areas. Next year more public high schools from lower socio-economic areas will participate. However, in mixed-sex schools (which tend to be public schools in the program) more boys tend to undertake engineering so having more public schools on board may impact on the gender ratio.

Through undertaking activities in various spaces at the University, working with staff and UTS students, and being provided with learning experiences similar to that of university students, high school students have had the opportunity to develop readiness for university.

One of the aims is to raise student, parent and community awareness on the 'future of work', relating to Australia's STEM challenges and opportunities. This has been successful for students undertaking the program, but there is no evidence that parent and community awareness has been raised.

Whilst it was set out that facilitating pathways for students with foundational academic and advanced technology proficiency back to UTS (or other universities) was to be considered, this aspect of the program is not yet in place.

Generally, communication regarding expectations and outcomes with UTS schools and staff in them was not strong. The School of Biomedical Engineering raised this as an issue. It was also raised by the Rocketry club and there was some misunderstanding by high school students regarding the purpose of UTS student involvement for some sessions.

RECOMMENDATIONS

One recommendation is that the expectations regarding involvement of UTS staff and students be set out more clearly than has been the case this year and these be clearly communicated. Feedback to various stakeholders during, and after the events have concluded should also be undertaken by way of meetings. This will allow feedback to be provided by both groups, which will help to strengthen the program.

As noted earlier, engagement with parents was very limited. This is an aspect that needs to be thought through carefully and be a feature of the program for 2020. Likewise, whilst there was discussion with industry, there was no engagement with them during lessons. The idea of engaging with industry is important so this will need to be developed so that this features as part of the program next year.

One of the valued outcomes of working in shared spaces, as reported on by both teachers and students, was the opportunity for the high school students to be able to see the university students and staff undertaking projects. A recommendation is where possible, this continues. Given the

increased number of classes this will be challenging and will require careful planning and communication with relevant stakeholders. The high school students were also very positive about directly engaging with UTS students through the projects they were undertaking. This should be expanded during 2020.

One of the concerns for the year 11 students was that the learning they undertook at UTS should support their learning towards the HSC more clearly. Whilst they stated they enjoyed working on practical activities, a concern was that these activities did not always link to their senior secondary study. A recommendation is that both theory and practical work link more closely to each other.

The high school students and teachers responded very positively to the idea of using different spaces and the resources in them. This should continue. However, the use of dedicated space is one that needs careful consideration. There were times where gaining access to shared spaces was problematic. A recommendation is that a dedicated space should be set up for the program. In discussion with Wanago staff the point was made that negotiations were underway to secure such a space. It is important however, that high students still have opportunities to work in shared spaces as this was seen as a strength of the program. In a dedicated space, it is important that storage space be provided to allow all students to leave projects at UTS rather than having to transport them, which was problematic for bigger projects.

An aim of Wanago program is to advocate for STEM education through data collection and building impact evaluation. This evaluation and one to be undertaken next year form part of the data collection and analysis process. A recommendation it to track the year 11 students who started at the beginning of this year and year 12 students who came later into 2020 to ascertain if any of them enrol as a student at UTS in 2021 and what degree they choose. A short survey or interview could be undertaken to understand ways that Wanago might have influenced their decision to attend UTS. Such data might also be used to help further shape the program.

The building of teacher capacity will need careful consideration given that the program is expanding and Wanago staff responsibilities are changing. The time for this and the expertise to draw on are several factors that need to be documented in developing a comprehensive Wanago strategy. Who

will be the supervisor for teachers off-site and mechanisms to support these teachers also needs consideration.

Consideration should be given to recognising the efforts that are provided by student volunteers. This could be done through presentation of a certificate and with offers to provide referee letters.

A further aspect that was raised by Wanago staff members was to draw on UTS expertise, such as the LX lab, to provide expertise. This will also need to be carefully managed next year.

INTRODUCTION

For many years Australia relied on a large percentage of its workforce to come from the low-skilled work force where agricultural output was one of the main exports. The agricultural sector has changed as has Australia's manufacturing sector. Along with these changes international competition has increased and technological advances have played a role in shaping the changing face of Australia's workforce.

As a result of these changes, and through policies of various Australian governments, there is now a move towards developing and supporting highly-skilled workers to help drive the economic prosperity of Australia. One way that this prosperity is being supported is through the development of Science, Technology, Engineering, Maths (STEM) skills. Australia's future will rely on "STEM to compete in the emerging sectors that new technologies will create, as well as in the existing sectors which new technologies will transform. Our workforce will require specialised skills in STEM as well as high STEM literacy across the board to sustain economic growth" (Office of the Chief Scientist, 2016, p. 2).

These STEM skills need to be developed at all levels of education, including primary, secondary and tertiary sectors of education. Yet Australian high schools often don't have the teaching capabilities or resources to engage students in STEM subjects – or to run these subjects at all. This lack of expertise means students are missing out on their first stepping stone to the next generation of jobs.

One way that these STEM skills are being developed for high school students at UTS is through experiences provided through the Wanago program. As promoted: "More than a stepping stone, the Wanago Program is a unique new pathway that connects high school students, and their teachers and parents, with higher education and future industries. It combines the delivery of Australian curriculum electives in university-like settings, alongside initiatives to inspire students, mentor teachers and raise awareness in parents" (Wanago program n.d).

Commencing in February 2019, in collaboration between UTS, the NSW Department of Education, several Independent and Catholic schools in and around the Sydney CBD, the collaborations include a:

- 1 year, Stage 5 (Yr. 9/10), iSTEM class consisting of 33 students from Sydney Secondary College (SSC), Balmain Campus
- 1 year, Stage 6 (Yr. 12), Design and Technology class of 25 students from SSC, Blackwattle Bay

Campus

- 2 year, Stage 6 (Yr. 11/12), Engineering Studies class of 21 students from 4 Independent and 1 Catholic School

In focusing on the structure of the classes, the iSTEM class and the Design and Technology class were structured so that the school teacher would work with his/her class and draw on the resources of the university. The Engineering Studies class was structured so that a teacher was seconded from the NSW Department of Education (DoE) for a two year period to teach students in a class from a number of schools. The purpose of the Engineering Studies class was to provide opportunities for students to undertake engineering studies who would not otherwise have this opportunity in school.

Further aims of the program are to

- Achieve 50% gender diversity.
- Improve access for students from low socio-economic backgrounds.
- Build teacher capacity through engagements with UTS academics and industry experts.
- Increase learning outcomes through the development of curriculum enrichment activities and projects (facilitated by UTS academics).
- Develop student readiness to university.
- Raising student, parent and community awareness on the 'future of work', Australia's STEM challenges and opportunities
- Advocate for STEM education through data collection and building impact evaluation.
- Facilitating pathways for students with foundational academic and advanced technology proficiency back to UTS (or other universities). [1]

This report is based on data that have been collected and analysed, which consist of the early surveys provided to teachers and students, as well as a mid-year survey completed by the Sydney Secondary College (SSC) students and interviews conducted with both teachers of the Wanago program in the middle of the year. A survey was provided to the year 11 students, from which, eight students responded (four students from one schools later provided feedback).

[1] https://www.uts.edu.au/about/faculty-engineering-and-information-technology/what-we-do/wanago-program

Interviews were conducted with teachers from the iSTEM class (Dr Chris Brunner) and Engineering studies class (Mr Grant Odei) at various points throughout the year. Grant is also a member of the Wanago team. Two interviews were conducted with other staff members of the Wanago team including Ms Rosemin Khan and Professor Myriam Amielh. Interviews were also conducted with staff at the School of Biomedical Engineering including Professor Joanne Tipper, Dr Nham Tran and Dr Trang Nguyen. Interviews were conducted with members of the Rocketry Club (UTS students) and with the two mentors on the year 11 class.

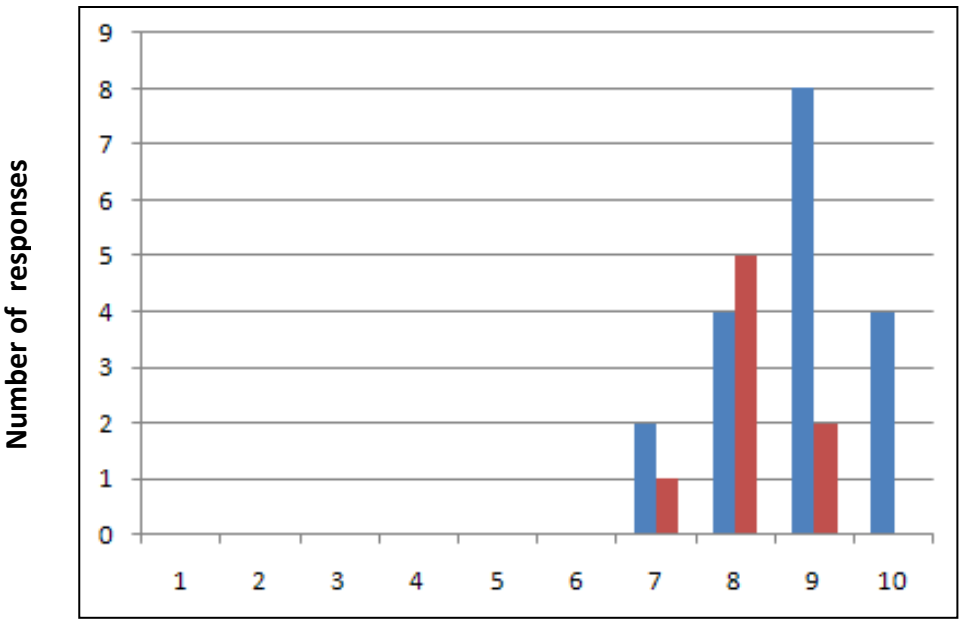
Additionally, data were collected from focus group discussions conducted with year 10 and 11 students who were asked about the projects they were undertaking and how being at UTS supported their learning. The projects included the year major design project, the year 11 brake project, the year 10 Formula 1 project and the year 11 rocket project. Additional data that is drawn on in this report include observations of classroom lessons of the year 10 Formula 1 day and on the year 11 rocketry day.

The information provided, based on collected data, is analysed, in part, through the UTS social impact framework, the Wanago Program aims and the UTS 2027 strategy statements. It is recognised that this is the first year that the program has been run and that many of the aims set out in the Wanago documents will take time to realise in the program and may be modified.

STUDENT LEVEL OF EXCITEMENT-AN OVERVIEW

One of the actions undertaken in the early and mid-student surveys was to ask students about their level of excitement as a way of tracking their engagement with the program across the year. In the surveys the question was asked: On a scale of 1 to 10 (1 being low and 1 being 10), how excited are you in undertaking the subject at UTS? The results of this are shown in the graph 1 for the year 11 students.

Degree of excitement for year 11 students in undertaking the subject at UTS



Graph 1: Year 11 feedback

The graph above shows the rating by students in the early (blue) and mid-survey (red) classes.
As noted earlier, not all year 11 students had completed the second survey so it is difficult to make firm judgments regarding levels of excitement over time. Of the eight students that submitted responses to both surveys, 3 students were at the same level and four students gave a lower response by one or two levels.

For the early responses students commented positively on access to resources/facilities and were excited about meeting new people as being at university, STEM learning, and doing practical work as exemplified by these comments:

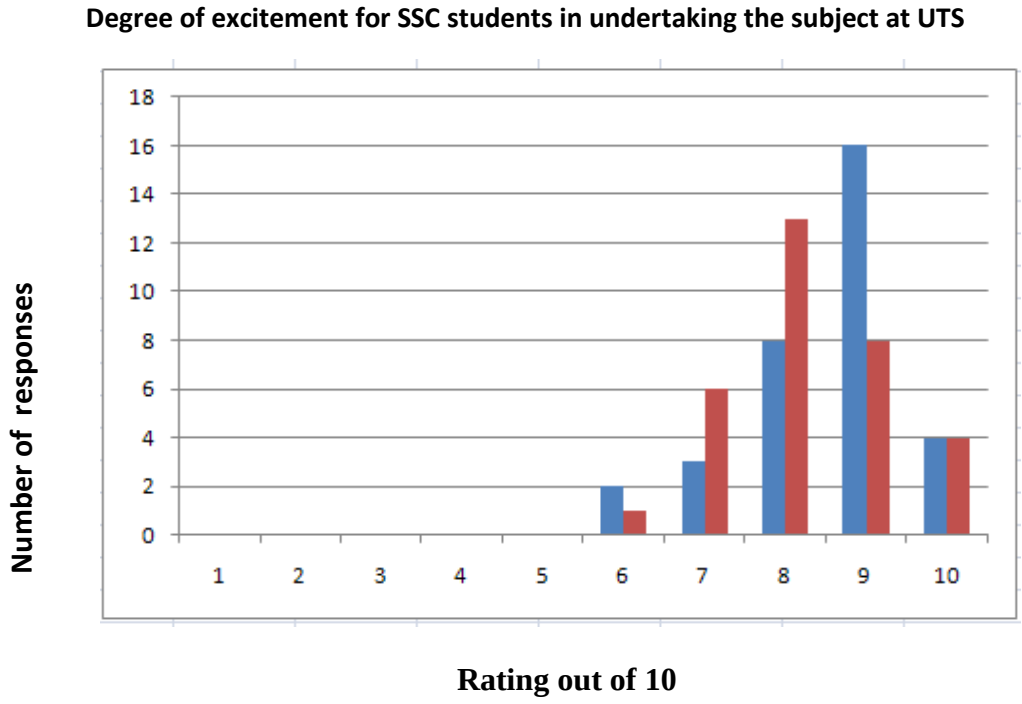
•*I am very passionate about STEM subjects and am very excited to be able to do a course I wouldn't normally have access to.*

•*I am so excited to take this course because it has never been done at UTS before and the fact that all the resources are available for us to use it makes the experience a lot more exciting. Also because I am attending an all girls school and engineering is considered a male dominant field, it is fun to defy the norms!*

There were a few negative responses from the mid-year survey being time and workload issues as well as the structure of the course as seen with this student response:

I don't like the fact that it is a 4 hour class once a week and I don't think there is much structure to the course

The year 10 student were also asked to rate their excitement level. The results of this are shown in the graph below:



Graph 2: Year 10 feedback

The graph above shows the rating by students in the early (blue) and mid-survey (red) classes. As can be seen there has not been a large change over that period. There is a slight decrease overall (in looking at levels 8 and 9) comparing the early response to the late response. The rating indicates a high degree of excitement in being involved in the program that is reasonably consistent across the two surveys. This graph demonstrates that the expectations of the year 10 students have been met through their participation in the Wanago program.

The reasons that students gave in the early survey for being excited to attend UTS included:

- *it would be fun*
- *working with other people.*
- *access to resources was perceived as positive*

There was a further mixed bag of responses- being at university, STEM learning, and doing practical work were some of these. There were a few negative responses being time and workload issues as well as the structure of the course.

In looking at the comments in the surveys, two main areas that emerged were engagement with people and access to resources. These aspects are examined next.

ENGAGEMENT WITH UTS STUDENTS AND STAFF

One of the aims of the Wanago program is to provide increased learning outcomes through the development of curriculum enrichment activities and projects (facilitated by UTS students and staff) for high school students. This aim is also reflected in the 2027 strategy, where connecting with the community to facilitate events that align with UTS's core areas of expertise and strategy feature is a focus.

In the surveys and discussions that have been undertaken, it is connections with UTS students for the high school students that have been an extremely positive experience as evident in the response below:

Coming to the university in the past 2 terms has helped me as I have had access to university students who can help me and give feedback on the work that I am doing.

The year 11 teacher spoke about university students who came and worked with the high school students which included in part, the rocketry team and the motor sport team. An example is before the school students started the brake module there was a presentation from the motor sport team where they went through ways they incorporate brakes into their sport. This presentation gave students ideas about different types of brakes and brake parts, which gave the high school students ideas about what they could do for their projects. This was a nice hook for the students, so that is was not just an abstract idea but how brakes fit in with the whole car system. The motor sport team spoke about the materials they use and there were opportunities for the high school students to ask questions.

The importance of training for university student helpers was raised as an issue. The year 10 teacher stated that sometimes helpers were not provided with a lot of back ground information to support the secondary school students. When the Women in Engineering visited, the year 10 teacher stated that although he felt he had organised the event carefully, the feedback from them was that they did not really know what was expected of them. The school students also did not clearly know the purpose of their visit.

One of the features of studying at UTS that the high school students reported on was being able to see UTS students working and studying. Whilst the school students did not have direct access to the university students working in tutorials, being in the same room was seen as being beneficial. The school students could see what projects the university students were undertaking, and see them come to fruition, which were not hugely dissimilar to their own projects.

Mentoring

During the Wanago program there were many individuals who supported learning for the high school students. Some of these people came in for one-off sessions and two university students who regularly supported year 11 students. It is the latter group that is discussed in this section.

Various definitions of peer mentoring exist in the literature. In this report the following description is adopted: “Peer mentoring entails the informal sharing of information or expertise from people of the same or similar rank as well as colleagues across rank” (Davis, Provost & Clark, 2012, p. 446). As suggested by Ambrosetti and Dekkers (2010), mentoring generally involves supporting and providing feedback to the mentee without judgement or criteria.

There is a broad range of advantages in mentoring, both for the mentee and the mentor. Some of the benefits for the mentees include enhancing the sense of belonging and identity with the university school (Evans & Peel, 1999), early access to information about resources on campus (Clark & Crome, 2004) and importantly, academic success (Rodger & Tremblay, 2003). Significantly, supporting first year students through mentoring programs increases their likelihood of academic success (Hall & Jaugietis, 2011).

There are a number of benefits identified for mentors in the mentoring relationship. One such benefit is the development of valuable lifelong professional qualities (Drew, et al, 2000). Another benefit includes the development of leadership and communication skills (Garringer & MacRae, 2008).

The year 11 class had two mentors that supported learning on a regular basis. Both of these university students were studying engineering and have also served as SPROUTS which gave them knowledge in both the subject content and also with the process of working with other less experienced students as mentors.

The high school students were asked about their experience in working with mentors. The students tended to consider any UTS student that worked with them in classes as a mentor so it is difficult to have a clear understanding in this area. There were responses regarding both learning about content and university life. In regards to content here were several responses:

•*mentors have given me insight into what it's like to be a team leader in the work force. i also learnt management skills including how to make an efficient gantt chart and 10 minute meetings*

•*helpful as they give insight into studying at uni and within the field as well as provide more support in class with areas of difficulty.*

There were also some reflective comments on how mentors had supported students' understanding of university life as typified by this comment:

They have discussed the path to going to university, including the Higher School Certificate, Subject Selection, Prerequisites and why they chose Engineering and the University of Technology, Sydney. These have benefited me as they have taught me to think about what I am passionate about, what I am good at, even if I decided to go to university to study Engineering or attend the University of Technology, Sydney.

The year 10 teacher found it challenging organising mentors given the amount of paperwork required from the school. Consideration might be given that the university put in place a process of organising mentors for secondary classes as part of the Wanago program. There may be instances where a one-off visit is conducted by university staff. In this instance a Working with Children Check (WWCC) is not required (see https://www.kidsguardian.nsw.gov.au/child-safe-organisations/working-with-children-check/exemptions)

Another challenge the year 10 teacher had was trying to organise regular mentors like the year 11 teacher had organised. The experience was that mentors stopped coming as the semester progressed as they had classes in the afternoon but the time for mentoring was in the morning. These issues meant that there were no consistent mentors supporting the class.

The aspect of being able to recognise mentors who volunteer with a certificate was raised as an important outcome.

Providing systematic mentoring that includes training of mentors regarding the content of lessons and the focus for each session was also discussed as being important. This is an aspect that the university can consider supporting for the future. There was discussion on possible online spaces that students and mentors might use to support discussion into the future. This approach supports contact with the school students and UTS students. Such a space would need to be moderated.

Staff connections

There was also positive feedback by the students in connecting with different staff members although this was not as pronounced as the positive feedback regarding UTS students.

The high school students were positive in their general feedback regarding UTS staff as indicated in this response from a year 11 student:
what an opportunity it is to be taught by professors and use their equipment.

There was also specific feedback regarding how working with UTS supported the high school students' learning as reported by a year 11 student in relation to the School of Biomedical Engineering staff:
We talked to the professor who guided us and explained the functions and uses of an instrument. This gave us an insight into how instruments function and its purpose in the biomedical engineering field.

ACCESS TO RESOURCES

In focusing on access to resources, aspects related to both physical resources and spaces are examined in the section.

Physical resources

Some of the physical resources that both the year 10 and 11 students used were the laser cutter, the lathe and 3D printers. Below are images of some of the resources used.

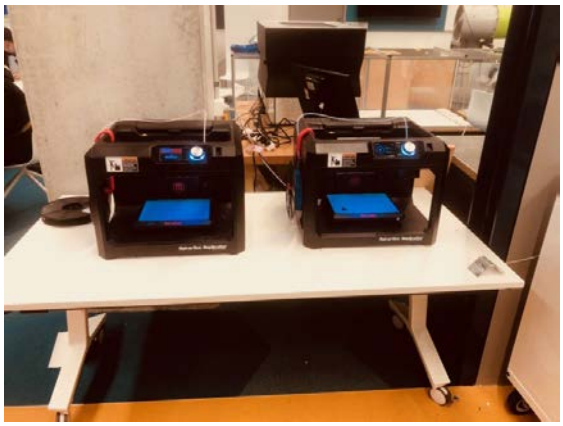


Image 1: 3D printers

Image 2: laser cutter

Image 3: lathe

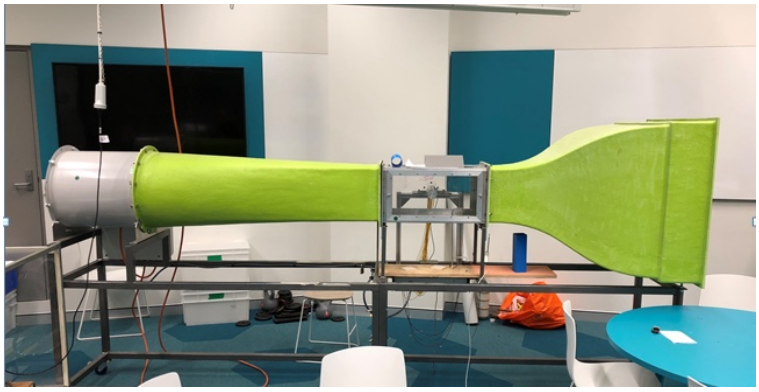


Image 4: wind tunnel

Both the year 10 and year 11 students used the 3D printers and the laser cutter for projects they worked on. The year 10 students also used the wind tunnel and the lathe to work on their formula 1 project. Both the year 10s and 11s also used other resources for different projects.

As a result of having access to resources all of the students responded that they found the lessons to be engaging and interesting. There were a number of different reasons provided for this response. Learning new skills and techniques was mentioned by a number of students as typified by this student's response:

•*the technology and the opportunities have been engaging and they have inspired me to try and learn more advances skills.*

•*The use of resources such as 3d printers, laser cutters and lathes at the university over the past 2 terms has given us the opportunity us to perform various tasks that would not have been able at school such as the laser cutting of badges.*

One important point made by one of the year 11 students in an interview was the opportunity to engage in practical work that she would not be able to undertake at her school. She explains:

At school I don't have the same opportunity to do the practical work.

This sentiment regarding practical understanding by being able to use university resources was also stated by students in the survey as evident in this response:

It helped me get a different and valuable understanding of not just casting types but in how I approach and understand topics in engineering through, for example, thinking about their practical use.

The importance of coming to UTS for the year 11 students is that they would not have otherwise been able to take on engineering studies. The schools the students attended did not have the physical resources and did not have teacher expertise to support the subject.

Spaces

The spaces that students typically accessed to support learning included the Protospace in building 7, the Mechanical Lab in building 11 and the Experimental Learning Studio (ELS) in building 10. These photos illustrate these spaces.

Image 6: ELS

Image 5: Protospace classroom

Image 7: Mechanical Lab classroom

Student experiences of using the spaces

Generally, the year 10 and 11 students were very enthusiastic in working in the different spaces as typified by this student's response:

we have had access to great facilities such as the underground work space that is equipped with milling tools and wind tunnels to make things easier for us to test.

There were some reflective responses as to what the space facilitated as this student explains:

The green lab, Underground lab and that one room with projectors all the way round the room. They have all been great for organizing our work and visualizing our problems to solve them.

Not all students found the spaces to be conducive to learning as one year 11 student explained:

The bean bag room and presentation classroom [ELS] do not feel like a classroom and hence I feel a lot of us are unable to focus and end up mucking around.

Teachers' views on the learning spaces

The year 11 teacher enjoyed working in the different spaces with his students but noted that space could sometimes be a challenge. His class does have access to the Protospace but this only allows for theoretical work to be undertaken. The Mechanical Lab was the preferred space, as this allowed for hands-on work as well as theory work to be undertaken. The lab was well utilised by UTS students which did make it challenging to access. There was not always guaranteed access to the space. The teacher suggested that in the future, if there is a dedicated space, or spaces that students do not feel like they are tagging in on, that will be ideal. In referring to a dedicated space, the teacher's interpretation of this was a space that the high school students had guaranteed access to.

The ELS was seen by the year 10 teacher as a very useful learning space. Having flexibility for students to be able to move furniture around to rearrange and create their own learning space was beneficial to support learning. Sydney Secondary College does not have such a learning space. The Mechanical Lab was also praised as it allowed for physical resources to be used. The workshop was praised with plenty of space and furniture.

While the ELS was found to be very useful, it was suggested by the year 10 teacher that a room that was a combination of that and the Mechanical Lab would be ideal. Tools that were suggested to be

useful include soldering irons but it is not possible to use them in the ELS. The space in building 11 was reported to good but it was not flexible. Having both flexibility and usability was seen as being ideal. Storage was a problem. Having storage closer to the classroom would be ideal so that tools can be easily accessed. Also, students need somewhere close to the classrooms to store projects. In-class storage is seen as the best option.

The year 10 teacher valued working in the workshop with students as it provided a window into student university life. The year 10 teacher noted that the Protospace and Mechanical Lab are very different to school spaces and that the high school students can see the university students working in the spaces and how they are being utilised. The high school students saw the university students making wind propelled cars and attaching Arduinos onto them. It is important then, that school students have opportunities to work in the same spaces as university students at the same time. Being able to mingle and get in there for his students was of high importance to Chris (year 11 teacher). He stated this access to shared spaces did not have to be all the time. Timetabling needs to be considered to enable acess for future practice. Seeing those spaces being used by university students could potentially minimise anxiety that high schools students may have about going to university.

STUDENT LEARNING

The students were asked about their learning in relation to the projects undertaken at UTS, both online and in interviews. Students were asked if they found the lessons to be challenging. There was some interpretation of the word challenging. Overall, the students stated that they were challenged but not overly so. Part of the challenge that students noted was learning to use the new equipment as this student explained:

The lessons are challenging because it is difficult to learn how to use the different technologies available to us.

None of the students stated that they were unable to understand and use these new tools/technologies.

Generally, it was the content that students found to be challenging as opined by this student:

The lessons are challenging because the task of researching, designing and developing a car to compete in the F1 in Schools Competition. I find project management to be challenging because it is something new that I had only just recently gotten a grasp on.

Having a teacher to facilitate the process was also noted:

they are not challenging cause our teacher is good at explaining.

The year 11 teacher was asked his opinion about the main highlight for the students in coming to UTS. The students have stated to him that they have enjoyed the hands-on learning afforded by the university spaces. They also enjoy the style in which learning is facilitated. They are developing a genuine interest for engineering. In a high school there would less hands-on learning. The year 11 teacher stated there is a lot of content (theory) and this has to be balanced with the practical work or else one element is lost. For the group the year 11 teacher worked with in 2019, he felt it is easy to combine the two but this may be a struggle with students from a low-SES background or who are not engaged. The year 11 teacher is currently using online spaces to support the theory work so that students can complete that partly out of teaching hours.

The year 11 students were asked if they would change anything for the remained of the year. Of the 12 students that responded to this question, seven of the students stated that they would like to do more theory. Several of their comments were:

- *I would feel more reassured if there were more classes on just theory and syllabus content as although I am enjoying working on all of the projects, I sometimes feel worried that we are not working through the content that we need to learn for exams.*
- *Focus more on exam techniques, calculations, and syllabus dot points. Focus more on prelim exams.*

A year 11 student also discussed this aspect in an interview:
I really do love the practical but sometimes I feel we're not spending enough time of the theoretical stuff that will be on the test. What we're doing for the questions now, it's not something we have learnt specifically in class, it's like you read the text book and get that out of school kind of thing. Whilst practicals are really fun I would also like to spend more time learning the content.

This response by the year 11 students highlights the considerations they need to give to their studies which are very theoretically based in the senior years. This focus on the exams and theory has been identified in a recently released NSW Curriculum review interim report (NSW Education Standards Authority, 2019).

Whilst removing a strong theoretical focus in years 11 and 12 may take some time, a consideration is that the curriculum for the Wanago students be structured in such a way so that both theory and practice are integrated. This situation was identified in a comment by one of the year 11 students:
Theory and practical work didn't correlate a large portion of the time

Later comments submitted by 11 students echoed this response. However, it should be noted that some of these concerns were because the year 11 teacher was facilitating a more independent way of learning, similar to university, which some students found challenging.

Based on feedback from the year 10 and 11 students, in being able to benefit from the resources and spaces that UTS has to offer, it would appear that having younger students (such as year 9 and 10) would be better where they are able to use the resources and spaces in a way that fits in more closely with the curriculum without the constraints concerns of the senior curriculum. For the older students, a more integrated curriculum would support student needs.

Year 10 major design project

This major design project has been one of the main projects undertaken in conjunction with UTS. There were three core elements involved for the students which include the Makey Makey[2], a server tower and an Ardunio[3]. The design brief for the students was to produce something that could be used in everyday life that included all three core elements.

The students gathered resources from Reverse Garbage at Marrickville and then worked in teams to produce the product. I asked a group of four students that I interviewed if they could have produced the project back at school, which they felt they could. What they appreciated was the space that UTS provided for them to undertake the project. They felt that working in the space allowed them to focus on the project more so than if they were back at school.

One group designed a third arm which they attached to one of their own arms. It could be controlled by a touch pad located on a leg (see image 8). Their idea was it could hold a light or a tool thus freeing up the user to use both hands. Another group designed a set up with a camera mounted to a bike handle (see image 8). The camera was able to be moved left and right as well as up and down. This movement was controlled by different buttons mounted on the handle bar.

Image 8: examples of student projects

[2] https://en.wikipedia.org/wiki/Makey_Makey
[3] https://www.arduino.cc/

In addition to making the device, the students also produced a poster explaining the process. Image 9 shows the coding design for a back scratcher than one group designed.

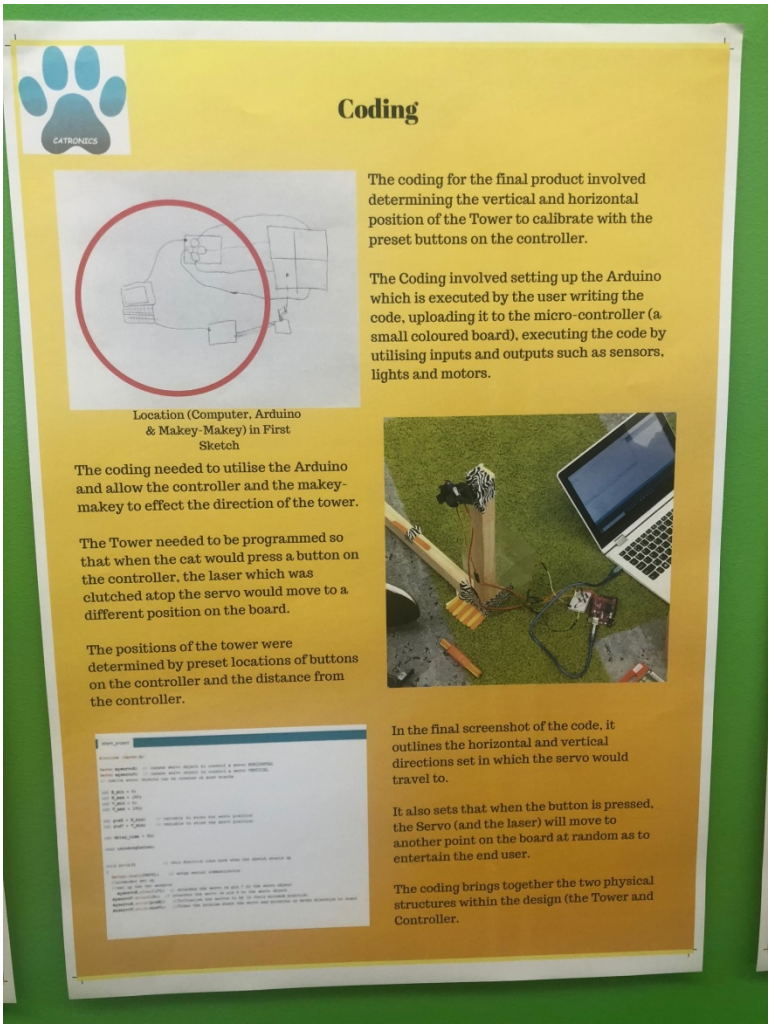


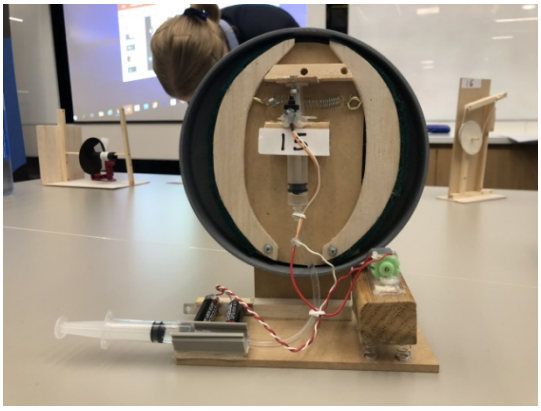
Image 9: poster for project

The students spoke about storing their projects. Initially they carried their projects to and from UTS which worked. Once the projects started getting bigger, their teacher carried the projects in his car. They stated they would have linked to have left the projects at UTS. The students were asked if they had any suggestions as what the university might provide if the project where to be run again. They stated that storage space would be useful and at school they could focus on other aspects, such as theory work, rather than the product.

The project concluded at the end of term one where students presented their projects in the ELS with parents and UTS personnel attending. The students felt having the presentations at UTS gave it a more formal feel compared to a school classroom. One student stated it was a space that felt like it was decked out and ready for presentations. The students also had access to digital screens to support their presentations, which they would not have had access to back at school.

Year 11 brake project

During term one the students developed technical skills in terms of how they build and put things together. This work allowed them to then build their models and see the science behind how brakes work during term 2.



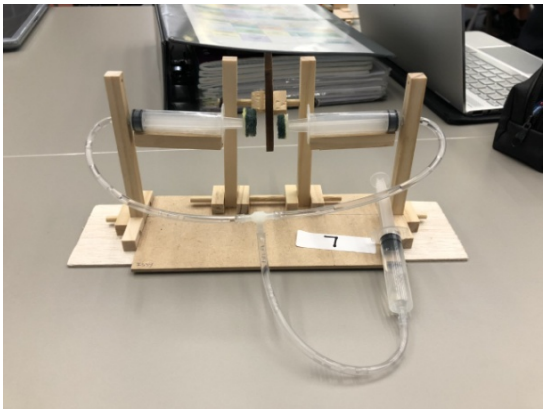


Image 10: models that students created and presented

Before the school students started the module there was a presentation from the motor sport team where they went through ways they incorporate brakes into their sport. This presentation gave students ideas about different types of brakes and brake parts which gave the high school students ideas about what they could do for their projects. This was a nice hook for the students, so that is was not just an abstract idea but how it fits in with the whole car system. The motor sport team spoke about the materials they use and there were opportunities for the high school students to ask questions.

The year 11 teacher explained the processes that lead up to that presentation where the students spoke about the work they did exploring ways brakes impact on peoples' lives, including individuals,

society and the environment. The task was for students to investigate their own braking system and then come up with a prototype for a breaking system.

The module the students undertook is part of the engineering studies module in year 11. It is the third module in the course. Students learn about the historic aspect of breaking systems to give them background knowledge as to how braking systems have evolved. They also learn about innovations that have been implemented throughout the ages. Through this work students developed a good understanding of what braking systems are.

The students presented their model to their peers and to a judging panel made up of various UTS staff members in engineering as well as the motor sport team. Having this exposure to university staff members and students provided for a genuine audience for the students. The year 11 teacher commented on the importance of students being able to present their work confidently. The environment created for the presentation was one similar to that where real clients are being pitched to. This opportunity to present to authentic audiences could be built up and promoted to schools.

Year 11 rocket project

The rocket project was undertaken during term 3. Students worked in pairs to design, build and test a rocket. They used OpenRocket[4] software to design their rockets, which is a free web-based tool, to test the design of their rocket before they started production. To design the fins for the rocket the students used Fusion360[5] and they cut out the fins using the laser cutter. In working on the project the school students developed a number of important engineering skills. According to a team member interviewed, these included concepts of pressure and gravity and how they impact the stability of a rocket in flight.

The school students were supported by members of the UTS Rocketry team[6]. The members of the team provided the students with details to design the rocket. They also provided them with the OpenRocket software and taught them how to use it. The team members came to a number of the

[4] http://openrocket.info/
[5] https://www.autodesk.com/products/fusion-360/students-teachers-educators
[6] https://www.facebook.com/utsrocketryteam/

sessions where school students were working on the rockets to help monitor progress. Image 11 is a picture taken of students working on the rockets in the mechanical lab.

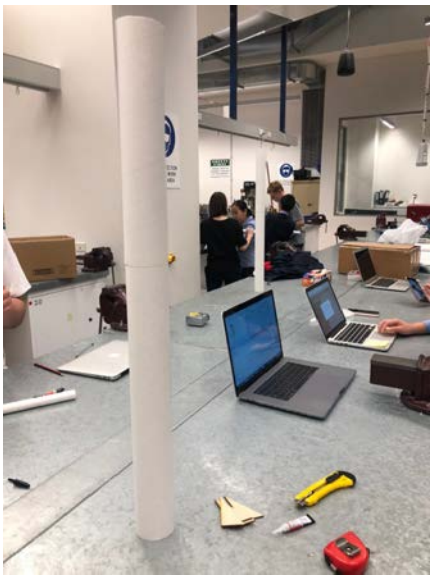


Image 11: photo of workbench in mechanical lab of rocket being built.

As a culminating event, a number of students spent a day at a park where they launched their rockets. This event was run by the Rocketry team and relied on their certification to launch the rockets. Many of the resources used on the day were provided by the team. The launch could not have taken place without them. Below is a video of some of the rockets being launched:

Video 1: rockets being launched

Given that the day was very close to exams for a number of students, not all pf them were able to attend. As part of the revisions made to modify the program for next year, the year 11 teacher has decided to run this activity early on in the year so that there are no clashes with exams meaning students will be able to attend the Saturday launch.

The member of the rocketry team that was interviewed was a uPASS leader at the time of the interview and has worked over four year with other university students to help facilitate their learning and like the mentors discussed earlier, has many skills to support the secondary school students. Another member of the Rocketry team tutors on subject and has experience in supporting learning.

The members of the Rocketry team learnt a lot in supporting the students and are making a number of changes for next year to better support the process. Some changes including opportunities for students to calculate rocket trajectories and to draw on data gathered during the rocket launch and to undertake some programming.

Year 10 formula one racing project

Another major project that the year 10 students undertook was to design and race a formula 1 car. This project started in term 2 and culminated towards the end of term 3 with a race day at Newington College. The students worked in groups for the project and each group contained five members. The roles included: team leader, design engineer, a marketing manager, a science officer and a manufacturing engineer.

The students were also required to producing a poster and a portfolio. The portfolio sets out how students came up with the idea, what sponsor ships they have and how they worked together to find and produce information.

The students related in an interview that the starting phase of this project was to learn about aerodynamics as that is very important when designing a car. The students also had to learn about the way to mill the cars and design different aspects and whether they wanted to print or mill them. The students used computer-aided drafting (CAD)software on their computers which was Fusion 360. They also used Autoflow software (a fluid dynamic simulator) to test the design. Below is a screen shot of the dimensions for the car used in their portfolio:

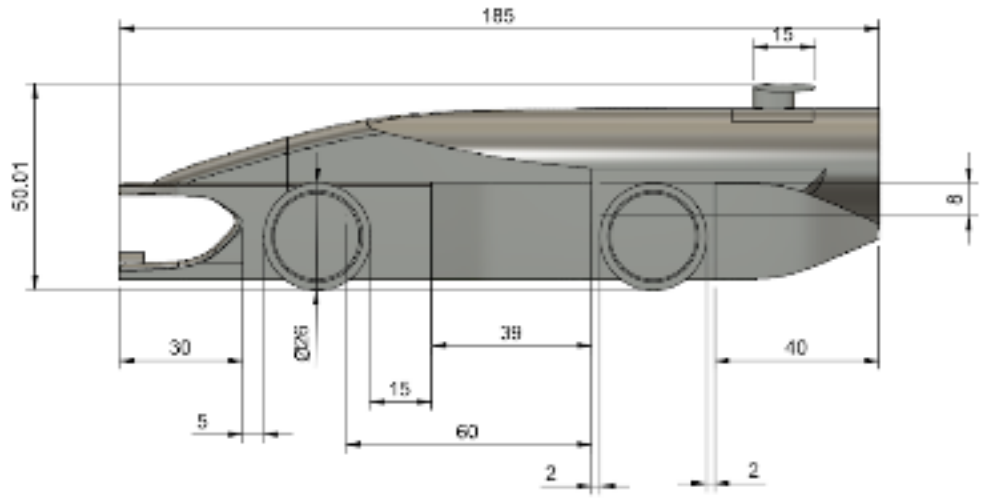
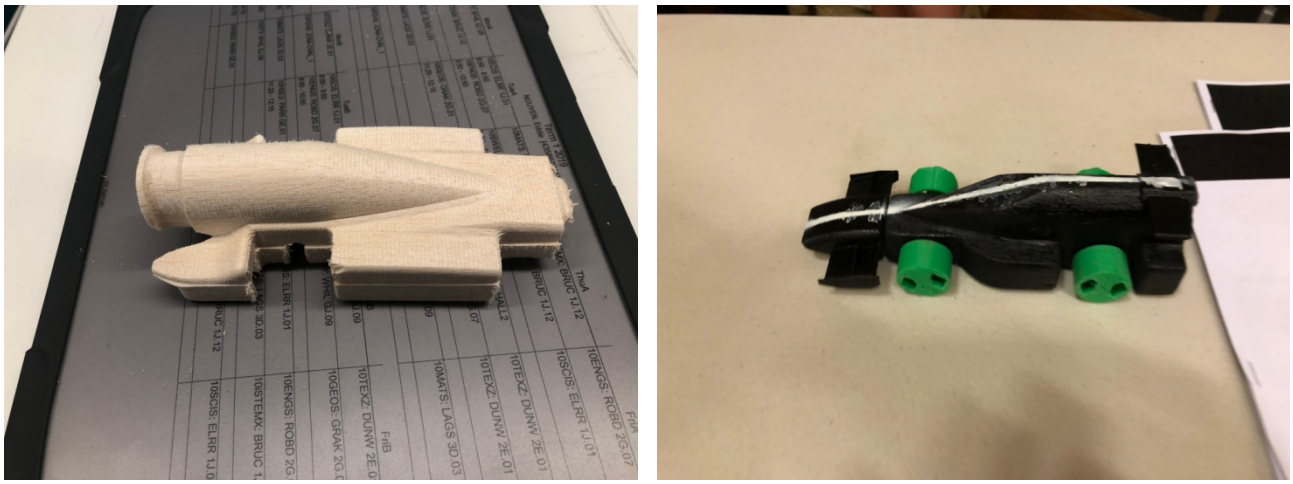


Image 12: car design

The students used a variety of resources at UTS to produce their cars. As seen on pages 17 and 18, the images show the different resources, which include the wind tunnel, 3D printer and the lathe to work on their formula 1 project. Image 13 shows a car after is has been completed on the lath and then when it is race ready with the nose cone (which was printed using the 3D printer) and wheels affixed



Images 13: car after being milled and ready for competition.

The students worked with a number of UTS staff to support their learning. On a whole day workshop different people came in to work with students in the five roles as discussed earlier

A student, who was the marketing person in his group, spoke about his experience: *They came in for me as the media marketing manager. They gave me insight into what big businesses like to use and general information about what information could be used to get sponsors.*

For the competition, the students were required to undertake a number of activities on which they were judged. These activities included designing and producing the car (which was raced against students from another school). There were two sets of races on the day. In one set the cars automatically shoot down the field by a countdown. For the second set there is a countdown and then the students manually release the cars. Below is a video of some cars racing:

Video 2: cars racing

Changes for next year

The students were asked in the survey if there was anything they would change for the remainder of the year. Apart from the aspect of more theory canvassed by the year 11 students (which has been discussed earlier) there were not many changes suggested by the students. Generally the responses for changes were positive as evident in these two responses:

•*maybe getting to explore what other students at UTS are doing right now.*

•*I hope we could continue with problem solving exercise for the rest of the year while learning how to use new technology on the way.*

There were only two responses that were negative in nature. The first response was related to the timing of the lessons which is not indicative of what UTS can provide:
having just the morning class as i think the afternoon class is a waste of time

The comment above is from a year 10 student where they altered times so for one week they had a three hour lesson and for the other week they had a one hour lesson. Given the amount of time required to travel to and from university that is a good suggestion

In relation to the amount of time given to lessons, a year 11 student made this comment in the survey:
Possibly for year 12, and breaking up the afternoon into 2 periods across 2 different days so that we have time to go home and come back another day during the week with questions and to have more continual learning. However I understand if this isn't possible due to the timetable of the teacher or other students.

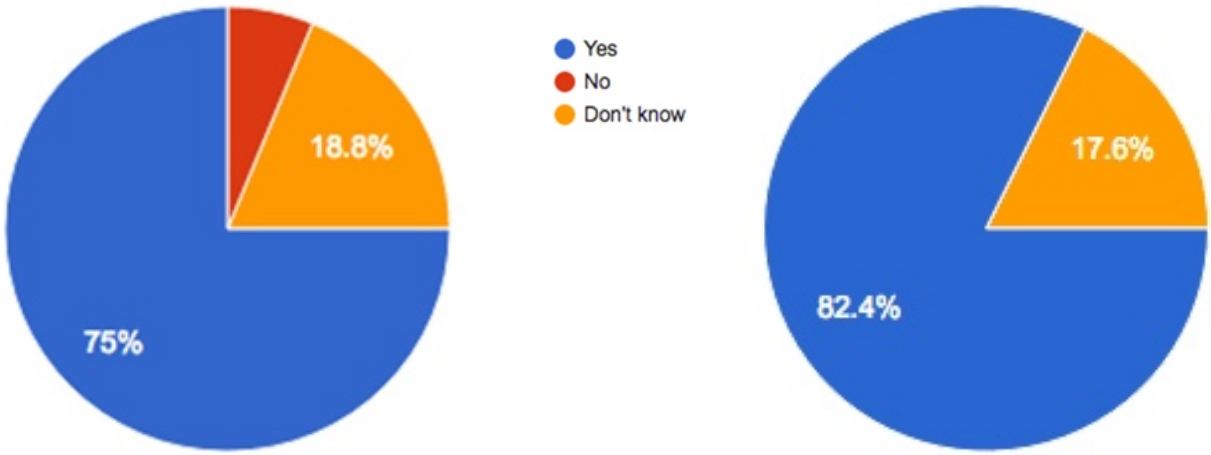
One large block a week is not as effective as two smaller blocks, where there is time (as noted by the student above) for students to digest information and to have the possibility to discuss issues related to learning. The issue of students travelling to and from school makes having two lessons per week challenging. It may be that one lessons a week is held on campus (with a focus on practical) and another lessons is run virtually though a platform such as zoom (with a focus on the theory). Overall, the students were very positive regarding their experiences at UTS.

DEVELOPING STUDENT READINESS FOR UNIVERSITY

The move from high school can be a daunting one, but with proper support the transition can be made smoother. Different rules and different expectations compared to high school, as well as literacy skills and social aspects can make the first year a challenging one for some students (Morosanu, Handley & O'Donovan, 2010). The support that students receive can make a big difference. Such support can be provided in the student's first year at university, or while they are in high school. One

of the aims of the Wanago program is to support students' transition into university while they are in high school.

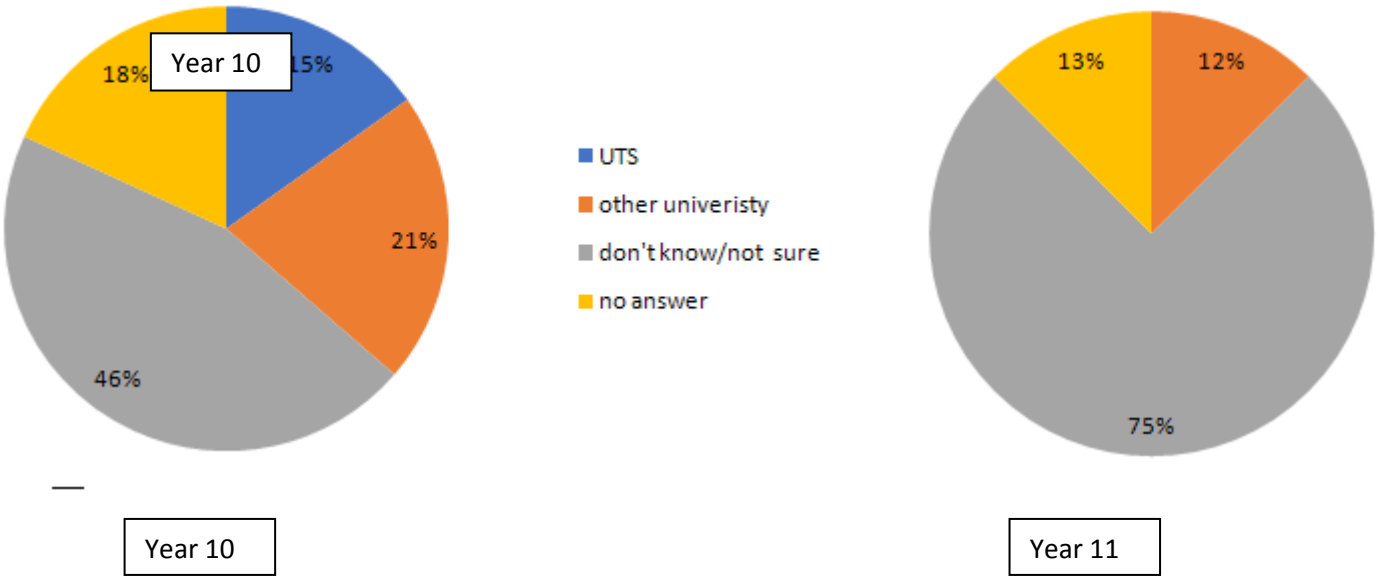
Students were asked in the early survey if they were intending to attend university after graduating from high school. For the year 11 students, all of the students stated they were intending to go to university. The results for the two year 10 classes are shown below



Graph 3: Year 10 response to attending university

Whilst the percentage of students reporting they did not know if they will attend university for the years 10s is around 18%, given that students were two and a half years from attending university, it is reasonable to expect this number will decrease. Across the three classes reported on, the percentage of students who expect to attend university is high, and therefore strategies to support their understanding of university can facilitate the move.

An aim of Wanago, although not publicly stated, is to encourage students to attend UTS once they do graduate from high school. Graph 14 shows the response to what university students might attend.



Graph 4: response to where students might attend university

For responses as part of don't know/not sure, in some instances students put a number of universities, UTS being one possible university. For the year 10 students, four students responded this way. For the year 11 students, six students responded this way. No year 11 student nominated UTS solely as a university they were intending to attend next year so tracking them next year to ascertain if any of them do enrol will provide valuable feedback if the Wanago program influenced their university of choice.

Students were asked about the reasons they might enrol at a particular university with the following responses:

- Location
- Reputation
- Relative's prior experience
- University ranking
- The type of degree

The earlier sections of this report have outlined experiences students have had participating in the Wanago program that have provided them with opportunities to become familiar with university

spaces, resources and people, which means when they start university they will have some understanding of university life.

In being asked about their thoughts on being at UTS, some of the students noted the people and activities around them in surveys they completed*:*
Seeing what the university students and staff do, plus people around them doing amazing things

and that this was different to school as noted by this student:
Learning at uni has been interesting it has a different learning space compared to school.

Another main response provided by students was the independent aspect of being a student at university:
•*i have learnt that you have to be self motivated*
•*You have to get stuff done and there aren't teachers to force you to do everything because you have chosen to attend*

The comments expressed by the students above illustrate the effectiveness of the program in providing such learning experiences that are similar to those of university students. In this regard, the program was able to provide a university learning experience for the students. While some students appreciated such opportunities, for other students, who were not used to such approaches, this was frustrating for them.

It is recommended that communication with school staff to understand transitional needs and how to support these whilst students are undertaking lessons at UTS can support students' transition to university.

Further to this, it is recommended to track the senior students from this year into 2021 to ascertain who does enrol from the Wanago program. Those students should be interviewed and asked how their experiences in the Wanago program facilitated their transition to university. Such an undertaking can help provide evidence as the effectiveness of the Wanago program.

FEEDBACK FROM THE SCHOOL OF BIOMEDICAL ENGINEERING

Whilst, it has not been reported on earlier, the year 11 students undertook a project which involved working with staff from the School of Biomedical Engineering (SBE) in the SBE laboratory.

The staff of the SBE was very enthusiastic regarding the program and the Head of the school saw it as an opportunity to support the undergraduates of the future. She also saw it is very important the school should be involved in outreach programs such as is being planned for Emu Plains and Penrith.

Some of the UTS students were involved in supporting the program. Given that there appears to be less of an emphasis on drawing on academic staff to support the program for next year, it would be advantageous to draw more on student expertise into the future.

The capability of the SBE to sustain an increased number of classes in the labs was deemed to be limited so this is a consideration for the future. This is also a consideration for other shared spaces such as Mechanical lab in building 10 and the Protospace.

At the moment the school is relying on the goodwill of staff to support the program so if staff were to have a greater involvement is was suggested then consideration might need to be given to incorporating their role as part of their formal workload. This would have funding implications for the Wanago program. The SBE is a small school and has few teaching staff so the ability to absorb new classes is limited.

They were also unsure as to the expectations when initially approached and asked if they were doing any exciting projects. They were not able to answer that as they are not experts in relation to the NSW curriculum. If there was clearer information as to what was wanted that fitted into the curriculum they felt they would be able to design some interesting projects.

The issue of resourcing in relation to materials used during the classes running in the SBE lab was raised. As pointed out by Professor Tippper, if projects that were offered via Wanago were to be truly exciting compared to a school experience, there needs to be some thought to the resourcing of these and how the school would be compensated. There was some suggestion by the Wanago staff around

this but it was unclear. There was also a request for clarity of who would pay for the university students teaching time.

One suggestion that was provided was to follow the model of the Summer school where a call-out is made for academics who want to teach into the program. The teaching team on level 12 (building 11) facilitated that.

The staff also felt that they would like some more feedback from Wanago staff as to the outcomes of the sessions that were facilitated. From this the suggestion was that more communication was needed into the future. The Head of the school was interested in knowing what type of projects the students undertook, what the students thought, what activities they undertook in the lab and what equipment they utilised and are there other activities they would like to do? She felt a more two-way process was desired. It is recommended that a meeting be held at the end points with various stakeholders to review the process and look at ways to move forward. Such meetings would inform the Wanago program and would also help schools and departments manage their resources and staff effectively.

We discussed the possibility of buddying up second year UTS SBE students with incoming first year students had participated in the Wanago program which the staff were open to. This would extend the mentoring program that is currently in place where mentors work with the year 11 students.

Dr Trang Nguyen expressed an interest in being more closely involved with the students and the work they were undertaking, both during the project and at the end. She stated that she would have liked to have seen the work students produced in an end-of-project presentation, much like the one that was organised for the brake project. She felt seeing what the students produced and listening to them would provide here with information that could be used to improve the type of the support the school offers.

STUDENT PARTICIPATION FROM UNDERREPRESENTED GROUPS

As noted by Timms, Moyle, Weldon, and Mitchell (2018): "Policymakers and providers face a dilemma in scaling kinds of initiatives to ensure equitable access, particularly for those who are already absent from STEM activities, such as girls, Indigenous students, those from rural and remote areas and from low socioeconomic backgrounds" (p. 14). This is also affirmed, in part, by the Office of Chief Scientist (2016).

One of the aims of the University is to provide opportunities for students listed above as evidenced in the Social Impact Framework and the 2027 Strategy, which is to provide for positive social change to enable increased participation for under-represented student cohorts. This is also focused on, in part, in the Wanago program where an aim is to improve access for students from low socio-economic backgrounds and to achieve 50% gender equity[7].

Currently, the students that are participating in the program since the beginning of the year do not appear to consist of students from low socially economic backgrounds. The year 11 students attend private schools and are not from low socio-economic backgrounds. St Aloysius College for example, has no students in the bottom socio-economic quarter according to the Index of Community Socio-Educational Advantage (ICSEA)[8]. Sydney secondary College has 9% of its students from the bottom quarter but it is unknown if any of the students that attend university are from that group.

As evidenced in a recent study, the socioeconomic status (SES) of the community a school serves impacts on participation and achievement levels in senior mathematics in Victorian schools. "This impact is most prominent in the more challenging mathematics subjects which are the same subjects often required for entry into tertiary courses in engineering, computer science, biomedical science and the like" (Murphy, 2019, p. 233).

The impact of low-SES means that for schools that draw on such students, they are less likely to take up the types of subjects that are needed for STEM subjects and ultimately, the types of subjects needed for successful participation in the Wanago program. As noted by Hackling, Murcia, West and

[7] https://www.uts.edu.au/about/faculty-engineering-and-information-technology/what-we-do/wanago-program

[8] https://www.myschool.edu.au/school/43684

Anderson (2013), enrolments in STEM subjects are significantly less in schools located in low-SES locations so ways to involve students that fall into this category need to be carefully considered.

In relation to gender equity in the Wanago program, there are currently more males than females attending in classes that started at the beginning of the year. In the year 11 class, 56% are male. One third of the students from Sydney Secondary College are female. In supporting participation for females in STEM, there are a number of factors that come into play. One factor is support from parents. In a recent study undertaken in NSW, even when parents created a supportive environment, there was little evidence indicating that girls were encouraged to pursue STEM (Lloyd, Gore, Holmes, Smith, & Fray, 2018). The authors of the research note that boys were more likely to name engineering professions as favored STEM occupations while girls were more likely to name a career in the life sciences—most notably in marine biology. It should be noted that of the new schools that are coming on board there is a greater percentage of girls involved.

Another group often underrepresented in university courses is indigenous students where these students' participation and completion rates remain lower than those of non-Indigenous Australians (Gore et al., 2017). This low participation rate is also seen in schools, for example, in mathematics (Ewing, 2018). A focus of the University, as set out in the 2027 strategy document is to improve Indigenous student success and retention. This focus can be part of the Wanago program where early support can then provide a pipeline in to university to continue indigenous students' education. The University is well placed, through such institutes as the Jumbunna Institute, to support future participation of indigenous students in the Wanago program, and ultimately as university students.

The Wanago program can provide learning opportunities for students who have an interest in STEM and open up opportunities for students to try a STEM related subject, which may then influence their decisions to take up STEM learning, but as noted here, the reason students take up STEM learning are complex and largely outside the control of the university.

A recommendation therefore, is to investigate how disadvantaged students might be included in future Wanago programs and the types of levers that exist to ensure such participation. Whilst the school may have some disadvantaged students it may not necessarily be that students who participate in the program fall into this category. As the subjects the students select at this point (years 10 to 12)

are usually electives (and will most likely be into the future), the mechanisms for the University to attract disadvantaged students to undertake the Wanago program are limited.

Opportunities to encourage and support students from under-represented groups to successfully participate in the Wanago program will require discussion with school staff to select students who are disadvantaged and who also have a desire to undertake STEM related subjects. The impact of supporting disadvantaged students is the curriculum that is offered to students may vary in relation to those offered this year to ensure student success. This may have resourcing issues for the university staff running the program. It also has teaching implications as was noted by the year teacher

In increasing the level of students from a disadvantaged background, an increased level of cooperation and support from university agencies, such as Jumbunna for example, can be considered.

Further to this, a more comprehensive plan should be developed to identify the types of students from disadvantaged backgrounds that are being targeted, and how this will be achieved. Additionally, tools that can measure success for students from diverse backgrounds is measured, both in the short and long term also need to be developed.

TEACHER PROFESSIONAL LEARNING

As discussed in earlier sections, two teachers were involved in the Wanago program. This section focuses on the support provided to the year 11 teacher.

The UTS staff as reported by the year 11 teacher that supported him throughout the year is as set out below:

Term 1
Terry Brown (Mechanical Engineering)
Carlo Giampietro (Lab Manager-B4)
Robin Breun (Studio Activities)

Term 2
Dr Andrew To (Centre for Autonomous Systems)
Herni Winarta

Term 3 (School of Biomedical Engineering)
Professor Joanne Tipper
Dr Nham Tran
Dr Trang Nyugen

Term 4
Peter Brown
Rami Haddad (Tech Lab manager)

The year 11 teacher was asked if he had a mentor to support his professional learning. Professor Myriam Amielh, Associate Dean (External Engagement), was designated as the teacher's supervisor who supported him with his work plan.

Grant stated he had some contact with Associate Professor Anne Gardner, Head of School, Professional Practice and Leadership. Anne was able to provide him with some contacts to Boral cement. Anne also guided the teacher as to how he would be able to complete his work plan- something very different to a school context.
At the biomedical school the teacher consulted a lot with the academics to work out the best way to involve them in the subject as well as finding out some ways that he might use the equipment. The

teacher received support by the mechanical lab manager through the induction that was provided in how to use that space. One example of this was how the lathe could be used to incorporate engineering skills into the module that he was teaching.

The induction was on-going and provided at point-of-need. The manager also introduced the year 11 teacher to some of the contacts he has with TAFE staff across the road from UTS. The result of that contact is that students will be able to undertake welding in the future, which is not possible at UTS. While undertaking welding is not necessarily a component of the course, the teacher suggested that it will broaden students' understanding of the different properties of materials. Likewise the induction that was provided for the Protospace also contributed towards the teacher's professional knowledge.

The teacher felt there were some limitations in regards to the support he received in engaging with industry (this being one of the aims of the program). The teacher stated that there were plenty of industry contacts. However, he felt his struggle was to be provided the mechanism to work with them. He saw the purpose of working with industry was to engage with students in a relevant way, rather than them coming in to present one-off talks to the students.

The teacher felt that the industries, including Boral, BlueScope Steel and CSIRO were on board but that timing was an issue. Having a five hour time slot once a week meant that having industry visit UTS or students visit the sites, this needed to be done in that set time. The teacher added having students leave school for a whole day excursion was possible or that weekend visits happen although this latter option was limited.

There were no industry visits this year. Grant did contact some companies but was told to get in contact with someone he knows who can come in and assist but he does not have those contacts. Grant stated in the past there were educational units inside these companies but now it is based more on personal contacts. Such contacts take time to develop and maintain and a proper mechanism is needed for this, which currently, doesn't appear to be in place.

There was a lot of up-skilling and professional learning involved for the teacher and the need for understanding the systems and processes at UTS. The teacher felt that time for professional learning was limited.

MOVING FOWARD

The aims and scope of the Wanago program have changed since its inception last year. At the time of the interview in November it was expected that five new schools would come on board. One new class had started in term four of this year. Part of this has involved teachers coming to UTS as part of the Wanago program to professionally up-skill themselves. The teachers don't necessarily have an engineering background. They will need some sort of training, at least from a curriculum aspect. St Aloysius has a physics teacher who wants to teach the engineering course at the school so is being supported to learn the engineering content. These extra teachers coming on board will most likely be supported by Grant and this will have implications for his workload and the time he has to organise and plan activities will need to be managed carefully.

In addition to the expansion of schools coming to UTS is the expansion of external sites. There will be a number of schools participating the software design and development (SDD) course being facilitated by the Commonwealth bank in conjunction with UTS at South Eveleigh. There will also be teaching that will be carried out in the West. The Catholic Parramatta diocese has 2 trade centres; one at Emu Plains and one at Mt Druitt. Currently the Wanago team is negotiating to support teaching in those spaces.

One of the success stories for students has highlighted has been access to UTS students and staff members. The move to working off-site has implications for the support that can be provided by UTS students and staff for the school students as travel time to these venues will need to be factored into the way Wanago is facilitated and marketed. Staffing of these venues by trained Wanago teachers needs to be carefully considered and structures for providing professional learning opportunities to school teachers will also need to be considered.

One of the aims of the program is to increase female participation in engineering and this has been achieved. There has been an increase in female participation as more girls schools have come on-board.

Another aim of the program is to increase student participation from low socio-economic areas. There has been an increase but the number of students from low SES schools is still low compared to students from high-SES schools. One of the complications in working with public schools (which tend

to be from lower socio-economic areas from the group of schools currently attending Wanago) is that there tends to be more boys enrolling in engineering. This potentially means that lower SES schools participating means more boys participating in the Wanago program. This is a tension that will need to be managed.

One factor that was identified in discussion with Wanago staff was that there was not enough involvement with parents. A number of initiatives are to be put into place next year which includes newsletters that will be sent home to parents at the end of every term, meetings with parents as a group twice a year, once at the beginning of the year and once towards the end of the year to explain the Wanago program. Additionally, there will parent/teacher interviews conducted as would the situation in a school.

Finally, the evaluation of the program will continue into 2020. The aspects to be evaluated will need to be carefully considered in consultation with Wanago staff and the evaluator.

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