Nathan Holdinghausen – Gleeson College

20th March – 09th April (Term 1)

During the final weeks of Term 1, I was fortunate enough to participate in the Teacher in Residence program; a joint venture between the DECD, Advanced Technology Project and UniSA. The aim of the program is to provide both academics and teachers reciprocal insights into their respective curricula and to discuss strategies that may foster growth and strengthen results in the STEM subjects offered at high school. This will hopefully in turn, better prepare students for their time at University, should they choose to continue one (or more) of their STEM subjects at tertiary level.

The program was brought to my attention by Gleeson College’s then ATP coordinator, Mr Gerald Carey. Gerald encouraged me to think about what areas I would like to focus on and directed me to contact Pam Gerrard at the DECD. Pam was able to provide me with more detail about the program and provided an opportunity for me to meet with her and the people I would be working with at the University of South Australia, Mawson Lakes campus. The meeting included:

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<tr>
<th>Name</th>
<th>Role</th>
<th>Email Address</th>
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<tr>
<td>Celina Bolding</td>
<td>UniSA Connect Officer – Schools</td>
<td><a href="mailto:Celina.Bolding@unisa.edu.au">Celina.Bolding@unisa.edu.au</a></td>
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<tr>
<td>Deb Turley</td>
<td>Manager – UniSA Connect Programs</td>
<td><a href="mailto:Deb.Turley@unisa.edu.au">Deb.Turley@unisa.edu.au</a></td>
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<td>Russell Brinkworth</td>
<td>Program Director – School of Engineering</td>
<td><a href="mailto:Russell.Brinkworth@unisa.edu.au">Russell.Brinkworth@unisa.edu.au</a></td>
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The focus of the meeting was to determine possible dates for my placement, as well as activities that would best connect with some of the activities we undertake at Gleeson College. During this meeting, I was able to raise some of my initial questions about students entering University and the UniSA staff were able to provide me with answers or organise some activities that would allow me to connect with staff that could assist me. Questions I had included:

A) Assignment/Report structures and processes at University level.
B) Graphing requirements and components
C) Use of 3D printing technologies
D) Expectations of Tertiary Students
E) Opportunities for Middle School students to engage with the University
F) Noticeable traits that were either superior or lacking in the students that enter the Engineering faculty.

The meeting resulted in a timeframe and list of recommended activities being established, as well as an introduction to UniSA Connect. Outlined below is a basic rundown of what UniSA Connect has to offer, as well as services provided by the engineering faculty through the Hairy Mushroom Engineering label.

**Description as outlined in UniSA Connect Brochure:**

UniSA Connect focuses on inspiring science, technology, engineering and mathematics (STEM) study and career awareness with secondary school students. The suite of UniSA Connect experiential programs aims to promote further student STEM study and educational attainment. Professional development opportunities for teachers particularly focuses on new technologies and engaging pedagogies.

They are always looking at current, innovative research; determining how to make school students aware of the latest technologies and innovations in STEM subject areas. With the involvement of researchers at the university, they are continually working to produce programs to match school/ACARA/SACE needs to support and promote STEM in secondary schools. Programs already in place currently support curriculum in:

- Biology
- Engineering
- Physics
- Careers
- Industry
- Science
- Chemistry
- Mathematics
- Technology
Current Programs on offer include:

- Teacher Professional Learning
- Motion of Charged Particles in Electric & Magnetic Fields
- The Interference of Light
- 3D Printers
- Geospatial Science
- Aviation
- Nuclear Physics
- Penguin Pong
- Career Awareness Program
- Sensor Technology

**Hairy Mushroom Engineering:**

Hairy Mushroom Engineering or HME was founded in late 2014 to help address the shortage of engineering & electronics kits available for secondary schools. HME is operated by members of the Engineering faculty. Their aim is to bolster students interest by changing the products created and practicals conducted in STEM subjects. The activities and services they provide cater to all skill levels, and options are available for complete customisation.

**Services available include:**

- Digital Electronics
- Analogue Electronics
- 3D Printer Kits
- Toys & Promo Items

The item below is an example of a basic kit that has already been created and soon to be made available. It is a simple IR sensor unit that emits a sound when a hand is placed near it. When connected in series, these sounds differ in pitch and act as a piano. Items such as this could help with units such as Heat/Light/Sound, electricity and even important materials at Year 09 level.

![Figure 1: HME Piano unit.](image)

The ability to create various tools, instruments and kits is limited by price and resources, however from discussions with Daniel Griffiths, anything required at high school and especially middle school level should not be difficult to create given enough notice and specifics. Each article that is created comes with the option of onsite supervision at school or at the university and a complete instruction manual is provided. Class size would most likely be capped at 28 to deliver quality instruction and product. Daniel and I brainstormed a number of ideas including:

- Light/Speed/Distance Sensors
- Basic High Speed Cameras
- Buzzers and Switches
- Solar Cell activities
- Simple LCD sensors
- Shake tables
Experiences

Day 1. Introductory test Practical for LabVIEW software with Phil and Russell.

Students familiarising themselves with the drag and drop features of the LabVIEW Software Interface.

LabVIEW is a program used by educational institutions and companies to design, test and run various instruments. The advantages of such software include a graphical user interface (GUI) rather than a more complex code-based platform. It uses icons instead of lines of text to create applications. It appears to be easier for students to grasp the necessary basics of engineering using this platform and there appears to be substantial discounts on offer to educational institutions. In LabVIEW, you build a user interface by using a set of tools and objects. The user interface is known as a front panel. You then add code using graphical representations of functions to control the front panel objects. The "block diagram" contains this code. If organized properly, the block diagram resembles a flowchart.

Sensors can be purchased that link with the system and could be used for a variety of applications across the STEM subject areas including physics, chemistry, electronics and general sciences. It may also be used in conjunction with, or as an alternative to the LEGO MINDSTORMS product to produce sensor driven robots that could be used to demonstrate skills in programming and used in the classroom to assist in data collection.

Figure 2: Lego Mindstorms robot, interfaced with LabVIEW

Figure 3: Latest model Lego Mindstorms Robot (Retail $450)
Discussion with Russell Brinkworth, Engineering faculty members:

One of my requests during this placement was to discuss some of the issues that staff at the University are faced with regarding the abilities of students entering a tertiary environment.

Concerns raised by the staff are as follows:

1. One of the issues facing engineering was that specialist maths was dropped as a pre-requisite in order to raise numbers. The resulting issue was that students were entering the stream, not having had exposure to the correct level of mathematics. A secondary issue was that LESS students were taking the subject in high school because they did not need it. Russell is looking at attempting to offer “higher standing” to students who wish to undertake engineering that HAVE taken specialist mathematics. On a side note, it is agreed amongst the staff that a knowledge of Calculus is fundamental in obtaining success in engineering.

2. Communication by students via email (and at times in person), is very relaxed and informal. For example; students will simply attach a file with no message, ask questions without greeting or acknowledging their teacher, or begin messages with unprofessional statements such as “hey”.

3. Report writing and general literacy is one of the biggest issues faced by the engineering (and perhaps other) faculties. Be it grammar or spelling, the level must improve in order to reach the high standards required at tertiary level. Engineering students especially, feel as though they don’t need to write because they know how to solve equations.

In addition to this, it is believed that too many first/second year students require handholding and can’t find information themselves. They use Wikipedia, cannot reference properly and do not know how to source information. At secondary level, students are required to undertake a research project from Year 10 onwards, yet the skills required do not seem to be scrutinised enough. Further attention may need to be given to pure report writing skills.

It is generally believed that the SACE requirements for practical reports prepare students well for their tertiary requirements. (i.e. 3rd person, Intro, Analysis, Discussion etc.). Additional report writing skills are taught at university as required. However, one of the components requested in Engineering is the Abstract. A part of a practical that is not currently included at middle school or Year 10.

Furthermore, many students appear to have trouble explaining themselves correctly. They cannot relay the information in a manner that conveys sufficient understanding of the science and the processes. An inability to write in the 3rd person and remain impersonal is also prevalent. Doing so shifts the focus away from the concepts and onto the writer. At secondary level, we should be focusing much more on increasing this skill.

First year practical reports do not normally require apparatus or methodology as that information is given to the students. Rather than simply regurgitate this information, it may only be required in perhaps a late second or 3rd/4th year practical that is designed completely themselves, much like our CREST or STEM expo practicals. Continued use and evaluation of the templates we use is therefore highly encouraged.

Within Mathematics Directed Investigations, it is not uncommon for an investigation to follow a basic structure such as: Come up with an equation, solve for X, and explain it back. Often, a deliberate mistake in the equation or theory will be included to promote understanding and innovative, higher order thinking.

Any graphing work that is carried out is generally drawn using software with the same guidelines that we already have in place. This is necessary as virtually all work is submitted electronically. It is still important however, that students produce high quality hand drawn graphs, as they will probably be required to do so in exams and other situations.

4. Student basics in programs such as Office Suite were still lacking. Too much time is being devoted to learning how to do basics for word processing, table and graph production. These are skills that should be well ingrained by the time the students arrive at university.

5. The idea of the “Flip classroom” has not been well received at tertiary level. Staff who have attempted to use this method have received very poor course evaluation scores from students. All material has still be supplied
electronically, however in terms of content delivery via lectures and tutorials, staff have found that a traditional approach is still more beneficial. In terms of learning spaces, there are some areas designed in ways similar to our learning centre. For delivery of lectures, a well-thought out room design can drastically improve the learning experience for both staff and the students.

6. A general change in pedagogy may be required to shift from textbook-driven lessons in all faculties. Russell finds this approach dry and uninspiring, leaving little room for creativity and experimentation. If we look at the content, we could focus on how and where to apply it, make it useful and relevant and then teach the theory behind it. Essentially, a more Inquiry-based focus may be needed. If lessons are far too rigid, then the student’s ability to explore is limited, and they begin relying on being specifically told what to do at each step.

An example of this is the Light and Sensor practical for the second year engineering students. It requires the use of ultrasound and light sensors to determine distance and receive readings whilst testing different materials. Students must then investigate and explain the reasons for events such as:

Why sound registers on some, but not others.  What happens when the colour of the object is changed.
Why light registers on some, but not others.  What happens when the material of the object is changed.
What happens when the distance of the object is altered.

7. The idea of a 50%, or in our case (C-/C) passing grade is unacceptable for the work the students must complete. In order to progress through each year level, more needs to be achieved and retained. If you only know half of what you are supposed to, you’re not going to get by very easily. I am currently experimenting with mathematical concept books that allow students to express their understanding in different forms. It is my hope that the students will carry this resource with them into next year and use it to brush up on old material, in preparation for the advanced skills they will learn with each passing year. Should this prove successful, I will begin implementing a similar process in Science classes.

**Day 2: Careers Awareness Program and Numeracy Unit**

One of the more popular and very comprehensive programs on offer is the Career Awareness Program. I was provided a great opportunity to undertake some of the testing and go offsite to Ocean View College with the UniSA undergraduates to see the Careers Awareness Program in action. The program is operated by Kim Giannoni and a number of schools (generally DECD) are taking part.

The CAP normally employs a training system whereby the UniSA staff will train the school staff to deliver the program. Students log on to the relevant website and answer a series of questions that determine their personality style(s). It prints out a report that is sent to the university and the student’s school email address. This report provides a list of suggested careers (very comprehensive) and also links to the relevant courses offered by the university. The pdf version of the document allows the students to click on any profession and it takes them to the MyFuture website where they can click on the relevant state and look for courses and specific career information about their suggested career.

A total of 4 guides are able to be accessed as a result of completing the online activity:

<table>
<thead>
<tr>
<th>Career profile:</th>
<th>A comprehensive analysis of the student’s personality style. It informs students of possible career options, training and what traits identify them and how they can best be utilised.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent guide:</td>
<td>This guide provides parents and caregivers with information on how to assist their child’s development by catering to their dominant style.</td>
</tr>
<tr>
<td>Interview guide:</td>
<td>For each specific style, this guide provides tips on how to prepare for job interviews.</td>
</tr>
<tr>
<td>Résumé guide:</td>
<td>Tips for what the student needs to put in a résumé.</td>
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Once the career profiles have been completed, students can be exposed to an extensive 1 on 1 interview session that allows for more in-depth analysis of their goals and personality styles. They fill in career mapping forms that
assist in guiding the students to career choices by identifying and reaching short term goals, in preparation for larger challenges. This interview session also allows the University staff to collect and collate data on student’s subject choices for Stage 1 and 2. This information is passed onto the school and is extremely beneficial in terms of planning.

In order to utilise the program to its full potential, it is recommended that the sessions be undertaken in a continuous manner (e.g. weekly until completion). Sporadic exposure to the staff and program can leave students lost and in some cases, disengaged and unenthused.

**Conversation with Celina regarding Numeracy program:**

The numeracy program units are designed and taught by UniSA staff but can be created in consultation with schools or programs they are associated with (e.g. SAASTA). The program I managed to observe is a Stage 1 numeracy program aimed at Indigenous Athletes and uses a 94Fifty basketball (a ball with a sensor in it) to record a variety of sports data. The units cost around $300 each and the information is extracted to allow for graphing and statistical analysis. Other activities in the unit include the use of AFL dream team to show basic financial math using salary caps, as well as aspects of nutrition, intertwined with mathematics.

The preferred books used to support the program are written by UniSA lecturer Kevin Norton and focus on how to apply mathematical or even science concepts to real world situations, predominantly sport.

**Day 3: David Chan – 3D printing workshop:**

The 3D printing workshop exposes students to the basic processes required to design and construct 3D printed models. Students access a website called TinkerCad to complete their assigned tasks. The laboratory is fitted with a number of printers, dedicated teachers space and many display cabinets to showcase some of the items produced from 3D printing. The workspace itself could comfortably accommodate a full class of students and each is provided a laptop to work on. The workshop itself goes for 2 hours and the current task requires participants to construct a keychain with dimensions limited to (60mm x 30mm x 10mm).

Some of the objects produced by the 3D printer are pictured below:
In order to complete the task, students log into the TinkerCad website using standard email address, allowing them to work from home on their designs. The website has a variety of different lessons available to teach students the basics about 3D printing movements and designs.

The printer itself is uses laser etching to heat a fine powder to the shapes you require. Printing time is very long, however it depends on the size and detail of the object. It is able to produce moving parts and various other designs. Future applications could include printed clothing. Theoretically, you could download a design and print it to a perfect fit. If it goes out of fashion, place it in a recycling machine, which strips the material down and allows you to reuse it to print a new item of clothing. Different metals may also be used to print plated items. UniSA has also invested in a 3D scanner that could make copying and replicating objects a relatively easy task.

**Day 4: Science for Tertiary Learning – Anthea Fudge:**

The Science for Tertiary Learning course assists students in understanding various aspects of science at tertiary level. Applicants may be students who have struggled through high school, did not receive an ATAR, are mature age, or have had disability or family issues. The aim of the program is to teach the foundations of some of the Science streams so that the students can fully integrate into degree courses later on, having previously not met the initial entry requirements or prerequisites. The class is small in size (less than 20). They are provided with a comprehensive study guide and are expected to work and act as tertiary learners however, there is still a significant amount of hand holding required in the initial stages of the program to bring students up to speed on the required knowledge, processes and procedures used at tertiary level.

The course runs for 13 weeks and covers elements of the following:

- Basic maths calculations
- Basic Algebra
- Graphing
- Basic Trigonometry & Pythagoras
- The Periodic table
- Physics
- Chemical Equations & Bonding
- Chemistry procedures
- Practical report writing

The practical I witnessed was a physics practical on momentum in 2 directions. It used video cameras mounted above a customized air hockey table to show the movement of objects being hit together in an environment of reduced friction. The practical required the use of basic mathematics and physics formulas, as well as graphing software and techniques to investigate the law of conservation of momentum. Data was collected using **Movavi Video Editor 6** and then transferred to **Logger Pro 3.8.4** for collation and analysis.

*Figure 10: Logger Pro Screenshot.*
In terms of structure and engagement, it ran similarly to how we might run a practical at secondary level. Introductions, reminders about lab safety, a quick explanation and demonstration, before the students are left to their own devices to perform the practical. Instructions provided are very clear, step by step.

Following completion of the practical, I attended a tutorial in GP1-08 that focused on basic chemical reactions and bonding. It seems that rooms with round or grouped tables are preferred to a standard classroom design with all desks facing the front. The reasoning is to provide opportunities for peer interaction and discussion. Though this sounds good in theory, personal experience has shown me that this works better with senior students, rather than middle school.

The content of the tutorial bore a strong resemblance to that which is offered to students in years 08, 09 and 10. Basic mathematics involving percentages and Pythagoras were mentioned, as well as balancing chemical equations, using polyatomic ions and identifying correct units and subscripts. Questions asked were as basic as what elements make up H₂O, showcasing just how much knowledge the students needed to obtain before moving into other courses.

In my discussion with the tutor, Jing, I was able to learn that my current methods of focusing on report writing, use of tools such as equation editor and iScholaris were looked upon favourably. Like those in the engineering faculty, Jing wants to focus more on independent learning rather than spoon feeding content. He does not scaffold his assignments as we do, but definitely appreciates its value at a high school level. Jing considers referencing as an important issue and does occasionally prohibit students from using websites in their research. One major observation we discussed was that some of the students are too dependent on assistance and do not know HOW to learn.

**Day 5 – WASSN STEM Inquiry day**

WASSN is the acronym given for the Western Adelaide Secondary Schools Network. Students who attend these schools have been privy to a number of STEM workshops available at UniSA. Those directly involved in the program were in years 9/10 and were identified as advanced or accelerated. They made 6 visits to the campus, where they conducted a series of activities on sensors and geospatial design, as well as visits to the Planetarium. In the following year, those same students were invited back (Maximum of 6 from each school) to participate in an advanced project focusing on Sustainable Engineering, and in particular Passive Solar Design.

The aim of the day is to identify and study various sources of energy; and in particular, heat. They run through basic theory (year 08/09 level) as a refresher and then are introduced to Google sketch up. They try to model and render a basic structure, before being shown how to geotag it to any location in the world via google maps. Having done this, they can then choose a time, day and year to display what the shadows would look like on the structure.

![Figure 11. Basic object, geotagged onto a current University building.](image-url)

Students are then provided a scenario by the university regarding heat energy. Some scenarios include:
1. Landscaping around a University building to reduce reflected heat.
2. Appropriate angle of eaves on a new dormitory building.
3. Colour of glass on a new gymnasium roof to reduce heat transfer, whilst maximising light.

Students then proceed to one of the labs in the SCT building to test their theory and design. The students are provided a variety of materials to construct a basic model and use heat lamps and sensors to gather data on temperature change within the structure. The sensors can be altered to collect data at different timeframes and easily interface with a computer to produce excel charts.

Once the data has been obtained and analysed, the students construct a presentation of their findings and recommendations which they present to the class.

Summary:
The Teacher in Residence program has provided me with some fantastic insight into the opportunities available to students at UniSA, be it via their Connect programs or through full-time study. It is my hope that regular interaction between UniSA and the One+ campus will provide our students access to more advanced resources that may further their passion for STEM subjects.

All of the staff at UniSA have been extremely accommodating, making time and space for me to complete the activities I wanted to do. I must compliment them on their flexibility in allowing me to attend a variety of different sessions in different locations both on and off-campus. Any other teacher who wishes to involve themselves in this program will easily be able to integrate into the environment, provided they have an idea of what they want to investigate. My time spent with Deb, Celina and Russell indicated that although they are very eager to learn about how they can better integrate with secondary schools and advertise their programs, they preferred to guide me in the direction I wanted to take and offered all the assistance they could to make that happen. My only negative about the placement would have been the timing. There were a variety of activities that I wanted to involve myself in, however time constraints did not allow it. During our initial discussion, we thought that 6 half days may have been better than 3 full days, however there were some instances where I was able to stay a full day to get the full effect and see the end product of some of the activities; namely the careers awareness program and the WASSN STEM inquiry day.

My placement time at UniSA has increased my understanding of what, and just how important an engaging, high-quality, education is. It surprised me that even though there were so many differences between high school and university, there were also a significant number of similarities; especially in regards to the issues facing academics concerning student engagement, professional interaction and presumed knowledge. I was fortunate enough to discuss these issues with some of the University’s teaching staff and have been able to highlight areas of specific concern. Areas that I can now focus on in my own teaching, which will hopefully better prepare the students for further study.

Of particular interest to me was the use of 3D printing in the classroom. Currently, I have been liaising with Daniel Griffiths, who has been designing a printed slide rule that students may use to assist them with Integer calculations. The initial design was to be made entirely on a 3D printer, but he is also investigating the use of a laser cutter to construct these learning tools. Daniel and I had a great discussion about various instruments we could create in science class (possibly in a cross-curricular format with mathematics) that could benefit the many units the Australian curriculum requires us to address. The unit we have started with in the past is Heat, Light and Sound. We wanted to think of things we could do that could not only demonstrate those principles, but also be built on throughout the course of the year and applied to other units.

The placement has been a very valuable experience, highlighting for me areas that I can improve my teaching by altering the activities my students do, and the ways in which I deliver the content. I will continue to liaise with the UniSA staff to update our STEM subjects, discussing changes in technology, pedagogy and local or global issues that could allow for better outcomes for our students.

My thanks to all of those at UniSA who assisted me during my time there, particularly Deb, Russell, Celina and Daniel. My thanks must also go to the Gleeson College leadership team for allowing me to participate in this program. Finally, I would like to offer my thanks to Pam Gerrard, for her help in organising my placement and bringing this great opportunity to the attention of the One+ schools.