Article

A day in the life of an outreach student

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Geoffrey Weal is originally from Porirua, Wellington. He obtained BSc (Hons) degrees in both chemistry and physics from the University of Otago and is currently in the second year of his PhD in computational chemistry. During his studies, Geoffrey has volunteered for the Chemistry Outreach programme, in which he has promoted science to students of all ages, both in New Zealand and abroad. Geoffrey also leads the "Science for Supper" programme, which takes chemistry outreach to schools around Otago and Southland after working hours so that parents and the community can see what their children are learning in school.

Brianna is an undergraduate student at the University of Otago in the last year of a BSc in chemistry with a minor in physics. She is currently enjoying a summer studentship in the computational chemistry group. She has been involved in the Otago University Chemistry Outreach group for over two years and loves introducing kids to the weird and wonderful world of science.

Whiz. Bang! Whirl and BOOM! From the outside, this is what outreach is all about. But from the inside, underneath the "magic", there is simply a rough plan, no script, a great group of people and a bunch of experiments in the back of the ute. With tricks of sound and colour we can easily entertain and teach, but equally so with measuring cylinders and balances for conveying proper scientific practise.

Our goal is simply this: to demystify science and bring it down from the scary pedestal that it is put on and present it in a way that's obtainable for everyone. Science is not just for the talented students, and it's more far reaching than high-tech labs and whiteboards covered in complex workings. It's knowing to ask questions of the world we live in order to better understand it. If we pass on that message, then we are doing what we set out to do.

Let me describe a typical outreach day. It starts off like any other; get out of bed, have some toast and have a shower. Then the fun begins as I put on my black outreach T-shirt with cartoon scientists and a hydrogen peroxide stain on the back. Walking into the chemistry department, I see a bunch of fish boxes packed to the brim with gear and chemicals. There stands Dr Dave Warren, the outreach coordinator, getting the last boxes of beakers and conical flasks together. We fill up the liquid nitrogen dewar, grab a tub full of dry ice, pack up the truck and hit the road. As many as six chemistry (and non-chemistry) undergraduate and postgraduate students will attend today's outreach trip, all excited to hear what interesting yarns Dave has got for us today. What will this day bring I wonder?!

We arrive at the school, sometimes with children greeting us at the gate. Typically we visit primary and intermediate schools, as many students start to become discouraged from science between years five and seven (10 to 12 years old). However, outreach will visit high schools when invited. We drive up to the classroom and unload the gear. Ten minutes until the first class - time to set up the first experiment. The team sets up, talking to each other about what to get and how to lay out the experiment, while the senior students talk through an experiment they have mastered with the new outreach students. Teamwork is an important skill for every outreach student to learn. It takes a team to run a class of up to 30 children. Everybody in the team knows to be constantly on the lookout for any tasks that need to be done and to provide support for the person leading the experiment. Everybody working so well together is what makes outreach so enjoyable, and it is impressive to see new students pick this up so quickly.

The class of year fives pour into the classroom. They see large measuring cylinders bubbling away, and look, point, giggle and chat in awe about what is bubbling. The teacher quietens the class as one of the team takes the session. It is common for Dave to pick one of the students in the team to run a session. This is one way that students learn leadership and feel confident about being in charge of running a classroom. "Does anyone know what this might be?", we ask as we point to a pellet of dry ice. A few enthusiastic voices reply, "Liquid nitrogen?" "A really cold rock?" The children are thinking. "Is it ice?", one child asks. "Maybe. What does ice feel like on your skin?", we ask. "It's wet", another child responds. "Touch this. Does this feel wet?", we reply as we pass out little bits of dry ice. "No", the children observe inquisitively. "So it is ice?" "No!", the children answer as they play with the dry ice. A few more suggestion pop up, until one kid who remembers our last trip to the school or has seen it on Youtube yells out, "Dry ice!" "Very good!", we celebrate as we see science has stuck in this child's mind. We talk about what dry ice is and why it isn't wet - that it sublimes not melts. The teacher writes 'melt' and 'sublime' on the board, adding it to the literacy list for the school term. We add dry ice into the large measuring cylinder

with a pH indicator, making the water bubble and change colour. It takes a bit of time, then all of a sudden the solution changes from green through to yellow and orange (Fig. 1). "WHOOOAAA!", the children exclaim in excitement. Just like that we have them hooked.

Fig. 1. A primary school student mesmerised by a bubbling dry ice experiment

Now to drive an important message home to the audience. A simple science experiment like this contains big scientific ideas. Dry ice increases the acidity of the water, which changes the colour of the solution. This has real life consequences. Carbon dioxide (CO_2) contributes to the greenhouse effect by reflecting outgoing infrared radiation back to earth. The amount of CO_2 in our atmosphere (and thus the greenhouse effect) has increased over the past decade due to the increased consumption of fossil fuels. What is not as well publicised is the affect that CO_2 has on our oceans. Just like in this simple experiment, increased global CO_2 causes the acidity of the oceans and seas to rise beyond what life has evolved to endure. For example, the shells of shellfish dissolve under acidic conditions, which prevents them from growing to their natural size. This can be devastating for the food chains they are a part of. These ideas are critical for young minds to hear and allows them to make their own decisions and opinions about the future they want to live in. We ask, "Do you want to make all these colours?" "YES!", the children enthusiastically yell.

Next thing, we are boiling up a red cabbage, which acts as a natural universal indicator (as it changes different colours at many pHs). Many of the experiments that the team perform do not require chemicals only a university can obtain. In fact, most ingredients we use come from a supermarket, which allows the children to perform these experiments at home. This sends the message that anyone can do science, no matter whether at home or in a big scientific facility.

The team leaps into action. The university students pass out equipment, fill beakers of solutions, crouch to the children's eye level and talk the children through the experiment in a kind and playful manner, inspiring the children into a science they themselves have been inspired into. Outreach is not just for the children but for university students as well. Outreach invites all university students, whatever their degree, to attend. Over many outreach sessions, students become more confident as they learn their way around the experiments and the children, as well as the rewarding process of contributing to the community. Students also become more aware of how to communicate very complex ideas in a simple way to someone without knowledge of that field. Many students lack this skill after graduating from university, even though it is vital for any student to develop for the career they pursue. Outreach provides the environment for students to learn this critically important skill. This is happening while the children squirt solutions together, make a big mess and a plethora of different colours (Fig. 2). Most importantly, all students attend to have fun.

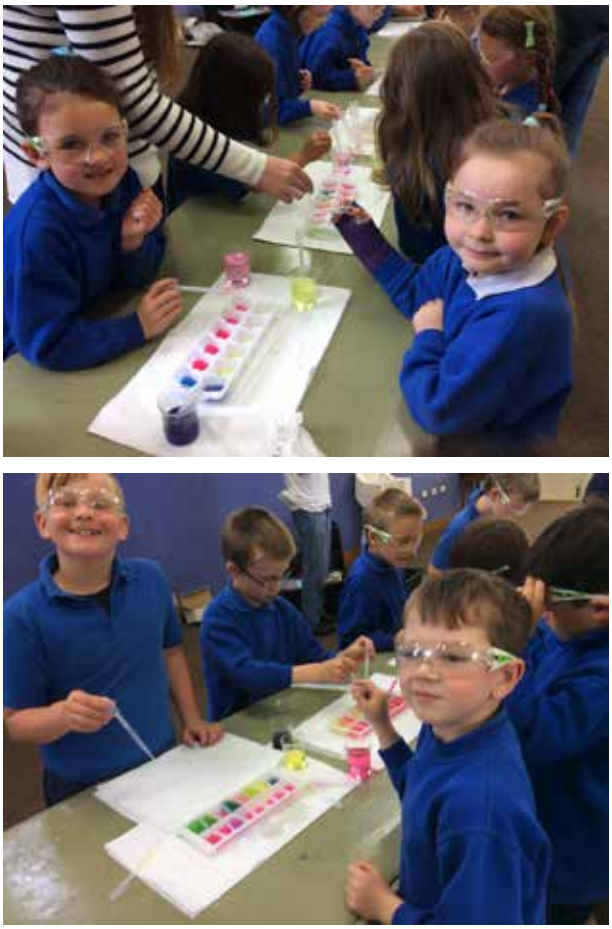

Fig. 2. Balclutha Primary School students make a big mess and a plethora of different colours using an acid, base and cabbage water

After a hard but enjoyable day of outreach, we clean all the glassware, wipe down the tables and pack the fish bins. We fill the ute and fall into the car seats as Dave drives us back to Dunedin. Halfway through the trip back to Dunedin, we always stop in at the dairy and get an ice cream, a longstanding outreach tradition.

If we are lucky, the children and teachers will invite us to attend or participate in out-of-school activities. In the past this has included helping in the school Olympics competition, playing at the end of year cricket game, zooming around on drift-trikes, and attending the end of year assembly. At the Waitahuna Primary School assembly, the children presented their long-term science experiments to their parents and community. One of the

memorable experiments involved measuring the thickness of cow patties by finger depth, aiming to understand how fertile the land was from a cow pat.

Outreach allows students to travel around Otago, Southland and other parts of New Zealand - to schools, libraries and maraes and to interact with students of all ages. However, we would have never thought it would take us all over the world.

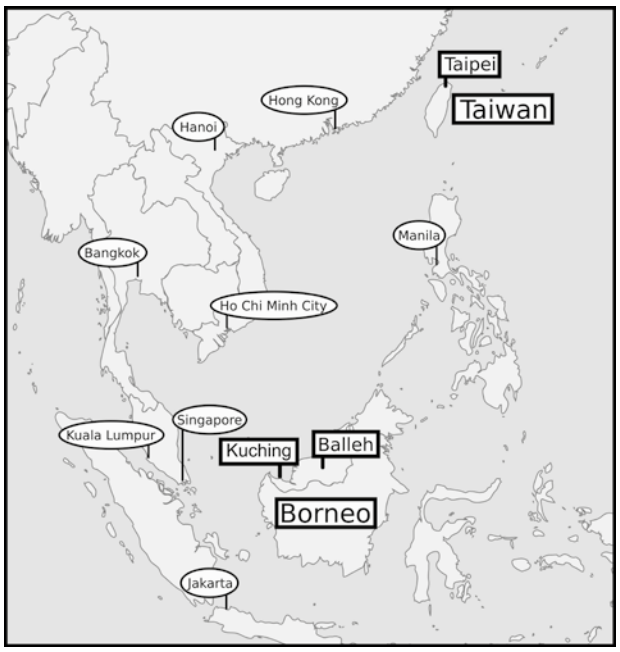

Fig. 3. Map of destinations travelled to by the outreach team (in boxes). Some well known cities are given in ovals.

So far, the outreach team has had the privilege to visit two countries (Fig. 3). The first was to Borneo, Malaysia. The Malaysian teachers' colleges, IPG Batu Lintang and Sarawak, invited us to travel to Kuching and to villages around the region of Sarawak, in Borneo.[1] This was a special experience as we got to travel to villages that we would have never known about or travelled to in our lifetimes.

A very special portion of this trip was our visit to the village of Balleh. This village consists of a few longhouses stretched along either side of the Batang Baleh river, a five hour boat trip on this river highway from the closest city. The outreach team stayed at SMK Balleh high school for a week. We arrived at the school from the jet boat, greeted by students and staff on the docks. Guided to the outdoor staff kitchen for a meal we met Speedy, the Principal of the school. He told us of the cultural significance of the land, the history of the people, and the distances the pupils travelled to this boarding school each weekend. All their students live on the river. They eat fish from the river, their parents work on the river and they travel to school via the river. This river is their lifeblood. Speedy also told us of the dedication of their teachers, whose husbands, wives, children and extended families do not live in Balleh. In fact, these teachers travel a total of 15 to 20 hours to be with their families at the weekends.

The team ran multiple classes each day with all the students of the school. One of the issues we faced was a language barrier, as English was not a first language of these students. However, fascinatingly, this did not cause a serious issue. The joy of science became a universal language that could be communicated to all the students (Fig. 4). The students became less shy once they had experienced us in the classroom. This allowed the students to approach us on our final day while we were testing toys for that night's science show (Fig. 5).

Fig. 4. SMK Balleh students play with PVA borax slime

Fig. 5. The students were curious about the toys we were playing with at SMK Balleh

"Would you like to have a go?" we asked them, holding out our new toys. This sparked a personal connection between us and the students. We continued to talk to each other about our lives in New Zealand and in Balleh. At the end of the science show, crowds of students came up to us, wanting photos and autographs, giving us their thanks and asking what we were doing next. Most importantly, the students wanted to keep in touch with us. We were lucky enough to catch up with one of these students the following year.

The second country that the team has visited is Taiwan. Annually, about 144 high school students from around Taiwan are selected to attend the Madame Curie High School Chemistry Camp. These students learn about a range of sciences and technologies, some developed in Taiwan. The outreach team of between six and eight people run a four hour project. This requires six months of precise choreography from Jacqui Kao, Prof. Chi-Young Lee and Dr. Dave Warren; from the vast amounts of equipment and chemicals required to the practicality of all 144 students preforming the experiments.

Otago student Sam Sutherland designed the first experiment for this science camp, based on his Masters research in polymer chemistry.[2] During Sam's research, he stumbled upon a literature report of a hydrogel created from nanoclay crosslinked with a diamine polymer. Sam created the hydrogels for the science camp. The students calculated the Young's modulus of the hydrogel by measuring the hydrogel's length of extension as 1 g aliquots of water were added to a bag, attached to one end of the hanging hydrogel (Fig. 6). The water acted as an applied force upon the hydrogel. The hydrogel's Young's modulus could be calculated from the gradient of the plot of the length of extension against water weight.

Fig. 6. Two students measuring the Young's modulus of their hydrogel

The students added water, measured the length of extension, and repeated. After half an hour, the students were shocked to see the hydrogel had stretched over 60 cm, was holding over 150 g of water and had not snapped. "When will it snap? Will it not break!" the students uttered in bewilderment.

This is an example of active research used to create outstanding outreach activities to inspire our future scientists and world leaders. This event is one of the toughest challenges for the outreach team each year. All the qualities of outreach - teamwork, leadership, confidence, teaching, seeing the bigger picture, inspiring - are applied with an excitement and energy to run this large class of students. The team thrills the students into the bright future and sheer joy that science has to offer (Fig. 7).

Fig. 7. The team hard at work to make the experiment a success

From overseas and back in New Zealand, behind the Whiz, Bang! Whirl and BOOM! that outreach displays on the outside, there is a deeper intention; to inspire the next generation of scientists, world leaders, artists, civil servants and engineers to think about the big problems facing our future and how we will deal with them. This is hugely important not just from a global perspective but also from a national perspective; to increase New Zealand's presence on the global scientific, technological and economic stage.

However, outreach only facilitates the teaching environment. Without the continuing effort of teachers and parents, children cannot continue to learn and appreciate science in their lives. Getting parents involved in their child's education is especially important as their parents' opinions and values reverberate in the home. However, it is rare that parents have the opportunity to experience what their children learn in the classroom. A new programme called 'Science for Supper' tries to address this by holding an after-work, interactive science session where both parents and children can learn about various scientific ideas with a range of exciting and messy experiments.

Our outreach programme continues to attract international attention. Besides our invitations to Taiwan and Malaysia, outreach has received interest from several international academics, some of whom have visited New Zealand. This includes Prof. Garon Smith, from the University of Montana, who often travels from the United States of America to New Zealand. He performs as 'G Wiz', the chemistry wizard, who shows that magic and science are simply one and the same (Fig. 8).

Fig. 8. Prof. Garon Smith as 'G Wiz', showing an experiment to the students

The success of outreach is due to the dedication of the extraordinary team of university students who repeatedly contribute their time. Outreach students have been involved in helping with or running outreach outings and events, designing experiments and programmes, videos, and even performing an outreach play. All this is done while studying for their university exams.

Fig. 9. Dr Dave Warren having fun riding a drift trike

A special mention must be made to Dr Dave Warren (Fig. 9). Dave began the outreach programme in 2008 and ever since has allowed it to grow, providing an opportunity for all students to contribute. His personality and leadership are aspects that help bring more students into the outreach programme and allow it to survive for everybody to enjoy.

If you would like to know more about chemistry outreach at the University of Otago, you can follow us on our Facebook page (https://www.facebook.com/chemotago/), website (http://www.otago.ac.nz/chemistry/outreach/index.html), YouTube (search Otagochemistry or NeverStop Recording) and twitter hashtag (#chemoutago) (Fig.10).

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Fig. 10. The University of Otago chemistry outreach Facebook banner, including photos of the team, experiments, people and places