Enlivening science for secondary school students: interschool competitions at CPIT

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Introduction

Competitions for secondary schools organised by Christchurch Polytechnic Institute of Technology (CPIT) now encompasses four year levels. Two separate competitions devoted to chemistry are open to Year 11 and Year 12 students, with two other competitions across all science disciplines offered for Year 10 and Year 13 students. The competitions are all well supported by local secondary schools, with typically 15-20 schools entering. Most schools are from Christchurch, but participation sometimes extends as far north as Kaikoura and south to Timaru.

The competitions had their origin in a single competition organised by Canterbury Branch of NZIC, for Year 11 students. This competition emphasised inorganic qualitative analysis, an emphasis we retain today for the Year 11 Competition. CPIT took over responsibility around 1997. Noting that secondary school students in the humanities have long enjoyed opportunities such as debating competitions and Stage Challenge, CPIT decided to extend these competitive opportunities to science students. We wanted to reinforce the idea that science is in every sense a social occupation (Fig. 1), and to help overturn the conception that people working in science are eccentrics who beaver away on their own, in silence. We started the Year 10 Science Competition in 2000, followed by Year 13 Science in 2005, and finally Year 12 Chemistry in 2006.

The format for each competition is the same: three students per team competing in a tight time frame, with an emphasis on practical activities. The emphasis on practical activities reflects the fact that most scientific activity (at whatever level) is intensely practical, and is consistent with CPIT's emphasis on practical work in its science qualifications. One entry per school is automatically accepted, with a second team accepted to fill the available space on a first-come basis. To help organisation at the school level, start times are the same (6.45 pm) across all competitions, and each competition ends around 9.00 pm with a supper – currently food from Subway.

In recent years, we have been financially supported by NZIC and by the Canterbury Science Teachers' Association. However, the bulk of the cost (principally staff time) has been borne by CPIT. The time commitment is considerable, with one academic staff member (the author) keeping an eye out for suitable activities throughout the year. Technician time amounts to 3-4 days for each competition; two or three technicians are kept busy all day setting up the various activities on the day, and doing the clean-up next day.

Competition activities

The Year 11 Chemistry Competition typically runs in September, toward the end of the third term for schools. As noted above, the emphasis is on inorganic qualitative analysis (both solids and aqueous solutions) using simple test tube reactions (Table 1).

Table 1. Information given to participants for the Year 11 Chemistry Competition, to allow identification of calcium carbonate, sodium sulphate, sand, sodium carbonate, sodium salicylate and sodium chloride as unknown white powders.

Litmus paper indicates whether a solution is acid, alkaline or neutral.
Barium carbonate, chromate and sulfate are insoluble in water.
Barium chloride and nitrate are soluble in water.
Group I carbonates are soluble in water and turn litmus blue, but **Group II carbonates** are insoluble in water.
All carbonates dissolve in dilute acid with the evolution of bubbles of a colourless gas (CO_2).
Sand is neutral to litmus.
Sodium salicylate is soluble in water and insoluble in dilute acid. When a few drops of ferric chloride are added to an aqueous solution, the colour changes to violet/red.
Sodium sulfate is soluble in water and in dilute acid; it is neutral to litmus.

A similar approach is used for the series of colourless solutions. There is nothing particularly complicated, but participants get tubes mixed up, do not follow instructions carefully, or run out of time. We have recently added pH buffer preparation as an additional activity. In this case, we deliberately choose buffers with one component that is slow to dissolve (such as oxalic acid).The Year 12 Chemistry Competition usually runs in May, shortly after the start of the second term. This competition focuses on organic chemistry, but assumes no background knowledge. Like the Year 11 Chemistry Competition, the emphasis is on problem-solving, following instructions, attention to detail, etc. Most of the evening is taken up with organic qualitative analysis of both solids and liquids, using simple test tube reactions of solubility in water, acid, and base; reaction to litmus; and decolourisation of potassium permanganate alongside a simple functional group test (e.g., precipitate formation with 2,4-DNP). As for the Year 11 competition, participants get tubes mixed up, do not follow instructions carefully, or run out of time. We often include a molecular model isomerism activity (e.g., make non-superimposable mirror images of $C_2H_3Br_2Cl$), an activity in which participants usually score well.

Fig. 1. Participants in the 2012 Year 12 Chemistry Competition

The Year 13 Science Competition is in mid-March, before the year's NCEA assessment load kicks in. Similarly, the Year 10 Science Competition (November) is timed to occur after senior students go on NCEA study leave. The Year 13 Competition deliberately introduces competitors to equipment that they will encounter at tertiary level. In 2012, we included spectrophotometric measurement of reducing sugar in an energy drink, gram staining of bacteria, and measuring the dimensions of a soil micro-invertebrate using a microscope. For the Year 10 Competition, activities have included calibrating a thermometer by measuring ice point, and calibrating an autopipette. These activities are sufficiently portable that we now offer the Year 10 Competition for South Canterbury schools, based in Timaru (courtesy of Timaru Girls' High School).

Both of the Year 10 and Year 13 competitions include a multiple-choice quiz covering all areas of science (including the history of science). Questions reward participants who are able to problem-solve, for example this question from the 2011 Year 10 Science Competition:

The radioisotope caesium-137 is an important environmental contaminant released from the incident at the Fukushima nuclear plant in Japan earlier this year. The electronic charge on an ion of caesium-137 is +1; the electronic charge on caesium-135 will be: (A) -2, (B) +1, (C) +2 or (D) +3.

Who won?

The intent behind running the Competitions has never been to sort out the "best school in Christchurch"! Nevertheless, schools (and their students) are often intensely competitive. Noting that league tables are currently controversial, some schools take the competitions more seriously than others, and not all schools participate every time. Over the years:

Eight schools have won more than once (Burnside High School, Cashmere High School, Christchurch Girls' High School, Christ's College, Hillmorton High School, Rangi Ruru Girls' School, Riccarton High School, St Andrew's College);

Thirteen schools have won at least once (the above plus Avonside Girls' High School, Darfield Hgh School, Lincoln High School, Papanui High School, Shirley Boys' High School);

Twenty four schools have been placed in the top five at least once (the above, plus St Thomas of Canterbury College, Christchurch Boys' High School, Hagley Community College, Kaiapoi High School, Kaikoura High School, Middleton Grange School, Oxford Area School, Rangiora High School, St Margaret's College, Unlimited Paenga Tawhiti, Villa Maria College).

From this it is clear that winning schools are spread across both private and state schools, single-sex and co-ed, town and country, and a wide decile range.

Conclusion

Competitions are a key part of CPIT's outreach to secondary schools, and unlike many "marketing" activities, the competitions have benefits to all parties. As well as meeting marketing outcomes (CPIT's brand; CPIT as a science provider; key institutional qualities such as an emphasis on 'hands-on'), we believe that the competitions enhance the position of science in secondary schools.