

# A College-Sponsored Laboratory Skills Contest for High-School Students: A Ten-Year Retrospective<sup>1</sup>

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Details of a number of chemistry contests that either include or consist of some form of laboratory activity for a variety of student levels have been published in this *Journal* and elsewhere (1–8). The most prestigious of these contests is the International Chemistry Olympiad, which has been held annually since 1968 (6, 8). Although similarities to other contests are inevitable, the University College of the Fraser Valley (UCFV) chemistry laboratory skills contest was developed independently by members of the UCFV Department of Chemistry in order to match our available resources and specific geographic location; thus our contest incorporates some features that distinguish it from those held elsewhere. The contest was initially envisaged as one of the activities that would take place during the provincially-sponsored Science and Technology Week, which at the time coincided with Canada's National Chemistry Week (NCW). However, the former was eventually phased out and the contest became our department's principal NCW activity.

## Objectives

Aside from promoting NCW and increasing awareness of our department and institution among the general public and potential students, we felt that a number of additional objectives could be achieved by sponsoring this contest. We were aware that in some high schools the opportunities for students to undertake laboratory work were very limited. By participating in this contest, students in their final year of high school would be given the opportunity to use chemicals and equipment that might otherwise be unavailable to them. Also, by focusing on practical aspects rather than theory, we wanted to stress the need for students to strive for excellence in work done in the laboratory. Finally, we hoped that the contest would provide an opportunity for increased contact between the instructors in our department and the teachers working in the high schools that provide us with the majority of our undergraduate students.

## Organization

Some information about our institution is needed to help understand the organizational details of the contest. UCFV is a multi-campus, degree-granting university college, located in the Fraser Valley, east of Vancouver, BC, principally serving the cities of Abbotsford, Mission, and Chilliwack, with a combined population in excess of 240,000. Chemistry courses are offered at the Abbotsford and Chilliwack campuses, but the laboratory skills contest takes place only in Abbotsford. As Mission and Chilliwack are both within a 30-minute drive, distance is not a deterrent for students from these cities who

wish to participate in the contest, with teachers often providing the necessary transportation. In the early years of the contest we identified 14 local high schools that we felt should be invited to participate; however, as years passed we became aware of some smaller independent schools, with enthusiastic chemistry teachers who also wanted their students to participate. In 2003, an additional laboratory was added to our Abbotsford facilities enabling us to increase the number of participants, so we began to invite some schools from outside the immediate area served by UCFV. By 2005, the number of schools being invited to participate had increased to 26.

Planning for the contest is an on-going task. We use different experiments every year that are selected from a variety of sources, and are modified and tested during the spring and summer preceding the contest.<sup>W</sup> In September, invitations are sent out to the chemistry teachers at local high schools inviting them to enter one or two teams of four students in the contest, which is usually held on the first Saturday of NCW. The rules for acceptance have varied over the years as we have sought to develop a system that is both equitable and convenient for the organizers. In the most recent version we reserved one spot for the school that provided the winning team in the previous year's contest and one spot for a school that had not previously entered the contest. Other schools were accepted on a first-come, first-served basis. The expansion of our facilities in 2003 enabled us to increase the number of teams accepted from 12 to 18. In the 10 contests that have been held, 18 different schools have participated, some of them attending only once, others returning year after year. Six different schools have placed first in the contest, with one school winning the contest on four separate occasions and a second school winning twice.

The numbers of teams and students that have participated each year are shown in Table 1. To date we have not administered any kind of survey to try to determine why some schools have never participated or have participated only once. Some of the numbers shown in Table 1 require explanation. Numbers that are not divisible by four arise because some registered students fail to come and because some years we have permitted students from schools that have a very low Grade 12 enrollment to participate as individuals and not compete for the team prizes. We exceeded our then nominal capacity of 50 students in 1998 because one team arrived without having registered. In subsequent years we have been prepared for such an eventuality to recur, but the situation has not arisen again.

After the invitations to participate have been mailed and suitable experiments have been selected, tested, and modified to fit into the time available and to match the abilities of the participants, instruction hand-outs are prepared. Many

**Table 1. The Number of Participants Each Year in the UCFV Annual Chemistry Laboratory Skills Contest**

Year	Number of Participating Schools	Number of Participating Students
1996	7	28
1997	10	40
1998	10	54
1999	11	45
2000	10	47
2001	8	40
2002	9	46
2003	11	67
2004	10	58
2005	10	66

of the participating students have very little laboratory experience; for example, most of them would never have used a Büchner funnel, a sintered-glass crucible, or a simple spectrophotometer. Thus care is taken to ensure that the prepared hand-outs that are given to the participants on the day of the contest contain full details of all the necessary procedures. Safety issues are clearly identified. Report sheets are also prepared and, because the emphasis is on the accuracy and precision of the experimental work, details of any necessary calculations are provided. The provision of the latter details enables us to use experiments that require students to perform calculations with which they may not be familiar.

Our regular lab classes are scheduled so that most of them do not meet during the week immediately preceding the contest. This enables our lab instructors, lab technicians, and undergraduate volunteers to have access to the laboratories for several days and to concentrate on the preparation of samples, apparatus, and reagents. We find it most convenient to provide each team with a box (or boxes) containing all the necessary glassware and to pre-measure reagents so that each team or participant has approximately the correct amount of each of the required chemicals.

### Contest Day

As the participants arrive, each team of four students is assigned a code letter that is used on all materials submitted for grading. The assignment of these codes is carried out by a person who will not be in the laboratory during the contest and will not be involved in grading. The list of schools and codes is then kept in a sealed envelope until grading is completed. In this way, the laboratory supervisors and graders are unaware of which school each student is representing and there can be no accusations of favoritism. Laboratory supervisors give a short talk on safety before the contest begins and each team is provided with the necessary details for

the experiments, including instructions for the use of instruments and apparatus.

The contest is divided into a morning and afternoon session, with lunch provided between the two sessions. Usually, each team will complete a quantitative experiment in one session and a qualitative experiment in the other session. However, in some years, when one of the experiments involves an extensive waiting period, participants are advised to begin work on their second experiment before completing the first one. Typically the quantitative experiment involves a titration, gravimetric analysis, or spectrophotometric analysis, and the qualitative experiment involves one or more syntheses. On occasion, a simple qualitative analysis may also be included. In 2000, the quantitative experiment involved the spectrophotometric determination of iron in a vitamin tablet, with a calibration curve being constructed by the students working as a team and then each student individually determining the iron content for his or her given tablet (9). The synthesis in the same year was the familiar preparation of alum from aluminum foil, with each student again working individually (10). Because this synthesis involved an extended waiting period, each team also attempted to identify some common polymers by a method based on published procedures (11–13). Throughout the contest we try to emphasize that students are participating as teams; thus we permit collaboration, for example, in the preparation of solutions that are to be used by each member of the team.

At the conclusion of the contest, our student volunteers assist members of our technical staff in the presentation of a short chemical magic show and a draw for a selection of door prizes. In order for the graders to have adequate time to assess the contestants' results, the winners of the contest are not normally announced until the Monday or Tuesday following the competition. In the early years of the contest we depended on donations from local businesses for prizes, but more recently, we received a small grant and have been able to give cash prizes. For the last three years, \$100, \$50, and \$25 have been awarded to each member of the first-, second- and third-placed teams, respectively. The winning team also receives a plaque to keep for one year and a chemistry reference book for use in its library or laboratory. When appropriate, we have recognized outstanding performances by individual students, particularly if they have not been on a winning team. Similarly, recognition has been given to teams that have performed exceptionally well on one of the two major experiments but have not finished in one of the top three positions. All participants now receive a custom-designed T-shirt.

### Evaluation of Contest Objectives

A critical assessment of how well the above objectives have been met reveals a varying degree of success. The annual contest has become a fixture in the calendars of some of our local high schools, as evidenced by their regular participation: 4 schools have participated every year during the past 10 years, and another 4 schools have attended all but one contest. Holding the event on a Saturday means that there are conflicts with students' other school-related activities and weekend jobs. Some schools are deterred from entering because they operate on a semester system and the semester in

which the contest is held does not necessarily coincide with the semester in which their Grade 12 chemistry course is offered.

Our local newspapers send a photographer to the contest each year, and the photos taken at the event have been published and the results reported. However, the accounts of the event have tended to focus on the successful students and their schools, with very little publicity for our institution or NCW. For several years photographs taken at the event have appeared in the NCW feature published annually in *L'Actualité Chimique Canadienne/Canadian Chemical News* (14).

An unexpected bonus for us has been the enthusiasm with which our own undergraduate students have volunteered to assist with the preparation of materials and the setting up of equipment, the supervision of participating students, and in the presentation of the chemical magic show that concludes the day's activities. A number of these volunteers had participated in the contest when they were attending high school and one now teaches chemistry in a school that regularly participates in the contest.

## Conclusion

We have attempted to demonstrate how a contest based on laboratory work can be incorporated into the Chemistry Week activities of a small-sized chemistry department. The fact that each year 40–60 high-school students are willing to spend an entire Saturday working in a chemistry laboratory is a strong indication of the success of our program.

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## Supplemental Material

A list of all the experiments used in the contest, complete with references to the appropriate source material, is available in this issue of *JCE Online*.

## Note

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