

First-Year Calculus Workshops

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Abstract

The first-year Calculus Workshop Program offered at UBC provides an activity where students meet once a week outside of lecture time to work on math problems in small groups. This may sound simple enough, but in fact the design and delivery of the program is a complex process.

Started in 2002 as a pilot project in one course section, the program grew each year and was extended to all sections and offered concurrently in two different courses in 2008, involving more than 900 students and a team of 25 TAs each year. To make sure the program was delivered effectively across all course sections, we undertook a two-year study whose goal was to identify possible pitfalls, implement changes, and measure their effects on students' attitudes and learning.

An expanded administrative structure and TA training program, more prominent learning goals, the addition of quiz activity as well as tighter course co-ordination in general have all combined to improve student attitudes of the workshops and produce a higher correlation of student performance in the workshops and their grades in the other components of the course.

The setting

Courses involved:

- MATH 180 – Differential Calculus with Applications to Physical Sciences and Engineering
- MATH 184 – Differential Calculus with Applications to Commerce and Social Sciences

MATH 180 and MATH 184 are 4-credit Calculus courses intended for students with no prior knowledge of Calculus.

Number of students involved:

	2008	2009
MATH 180	470	440
MATH 184	538	506

Course sections (2009):

	Lectures	Workshops
MATH 180	4	18
MATH 184	5	20

Workshops are . . .

- Problem-solving sessions

Students work on selected problems, applying concepts introduced earlier in lectures.

- A mandatory, weekly activity

Students have 3 lecture hours and 1.5 workshop hours in a typical week. The workshop grade makes up 10% of the final course grade.

- Multi-section

Lecture sections are broken down into workshops sections of 20-30 students. This year, 25 TAs working in pairs covered 44 workshops.

- Facilitation of student learning using a Socratic method

TAs are trained to use questions and hints to promote student problem solving, as opposed to demonstrations.

“Students can learn to appreciate their own discoveries when they discover it by themselves rather than a tutor solving the problem in front of them.”

Workshop TA – 2009

“Facilitation is much better than the other end of the spectrum, where you are just a ‘live’ solution manual.”

Workshop TA – 2009

Workshop format

- Room with many blackboards to accommodate:
 - approximately 25 students
 - one Graduate Student Teaching Assistant (GTA)
 - one Undergraduate Student Teaching Assistant (UTA)
- Groups of 3-4 students
- Problem sheet for the week is provided
- Work is done on blackboard
- At the end of most sessions, PHI = Problem to Hand In

What students do in the workshop:

They do the work:

- Write solutions on blackboard.
- Discuss with peers.
- Ask for help from the TAs (who are trained to not be *too* helpful).
- Write individual quiz on paper at the end.

Group dynamics are a factor!

Issues and concerns from previous years

- Topics presented late in lecture in some sections left students with insufficient background for their weekly workshops.
- Students dissatisfied with relation of course content to workshop content.
- Too much time spent off-task by students in the sessions.
- Too much variety between TAs in running of workshops (for example, spending long stretches on lecturing).
- Problem set production too rushed.
- Limited reusability in problem set production from year to year.

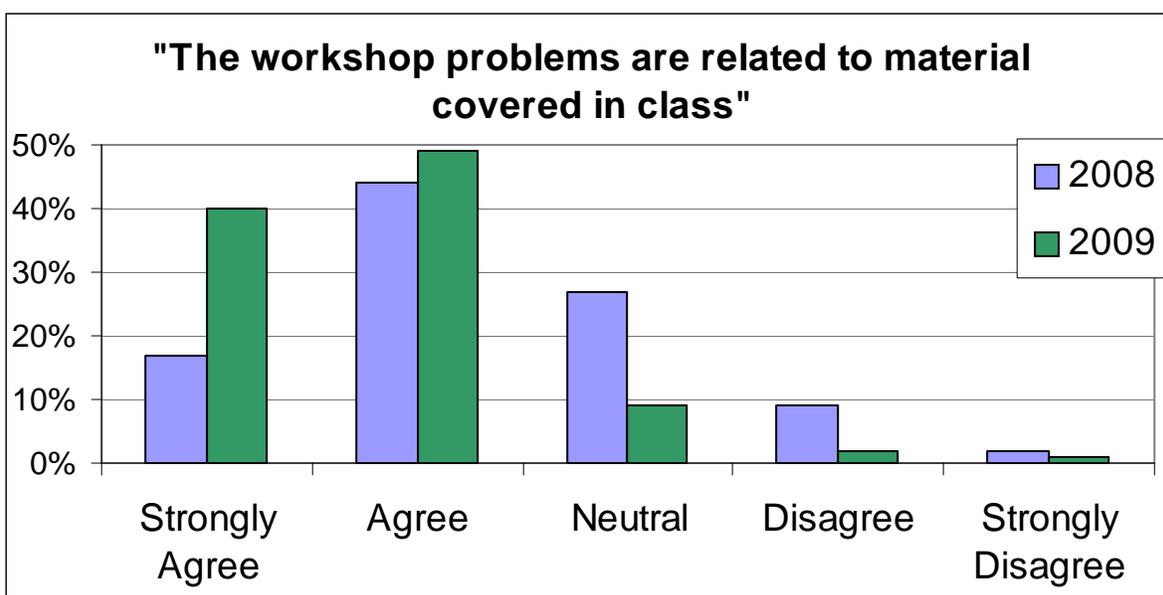
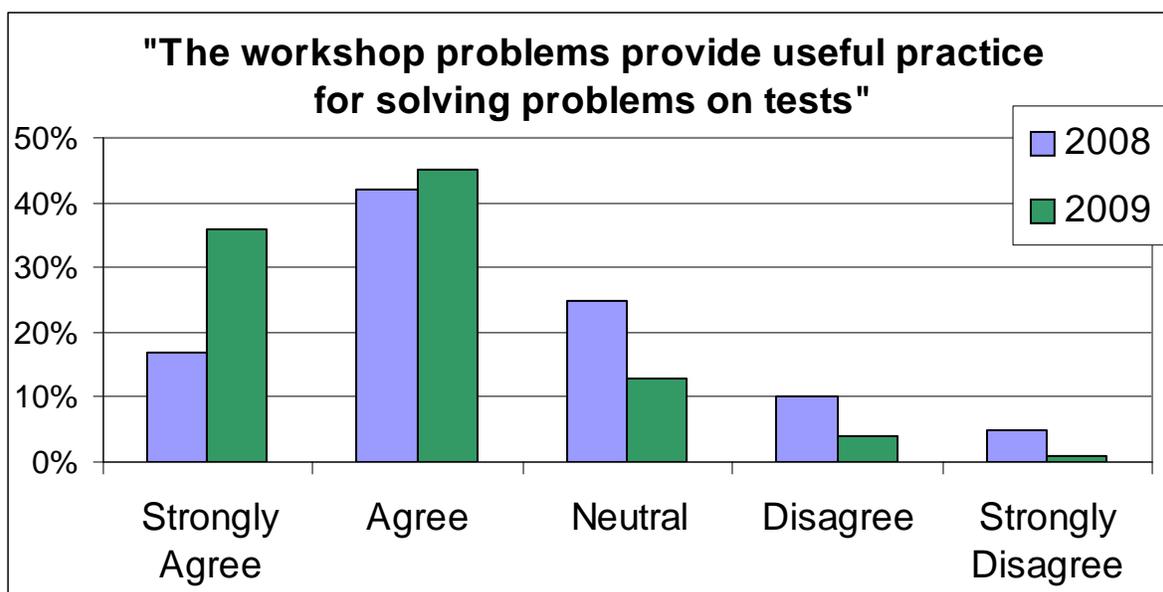
Changes made for 2009 session (Sept – Dec 2009)

- Clear Learning Goals stated on the weekly problem sheets.
- Problem to Hand In (PHI) was introduced keep students on task during the sessions and to provide further assessment of their workshop progress.
- Tight coordination of schedule and order of material between lectures and workshops.
- Production cycle for the weekly problem sets.
- Regular instructor meetings.
- Regular TA meetings and additional training sessions for TAs.
- One Head TA (graduate student) for each course to keep TAs coordinated, run training sessions, assist with problem set production, collect comments to assess problem quality.

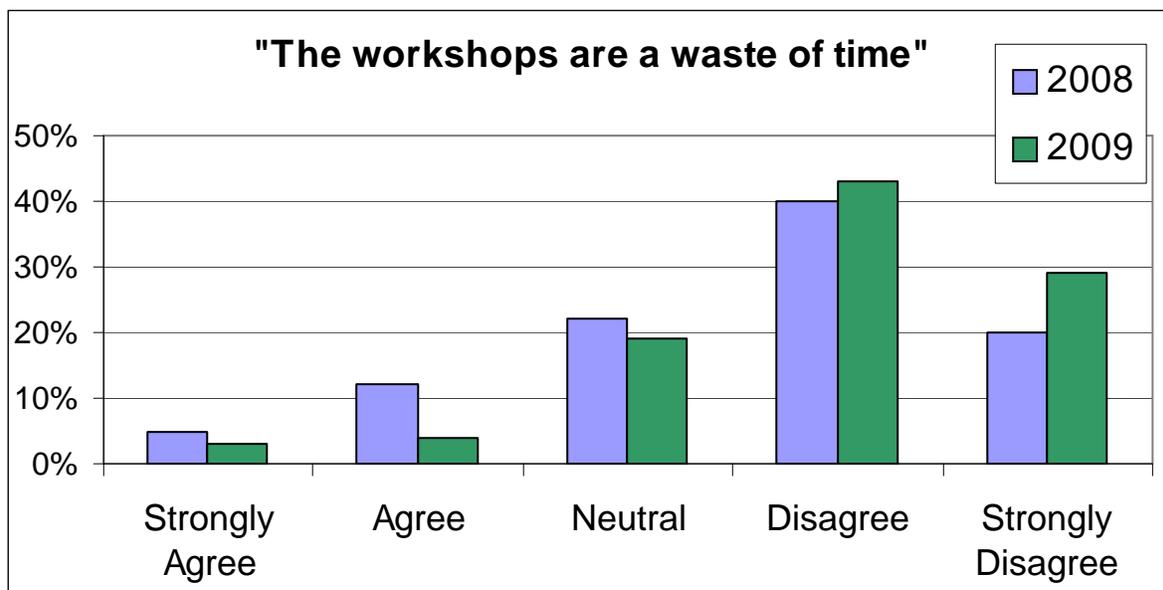
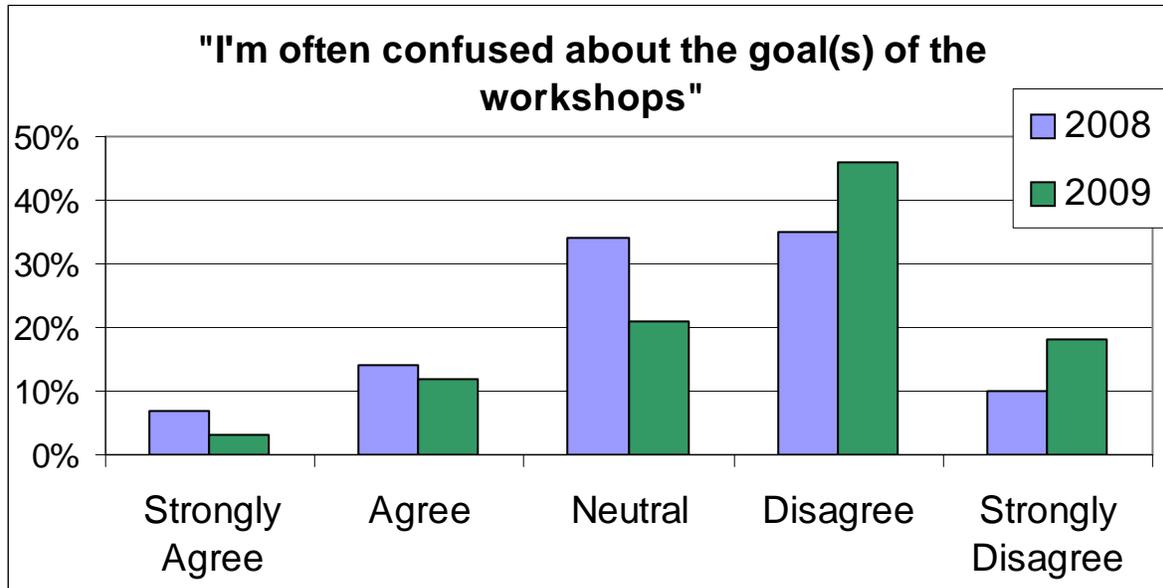
Results

1. Changes in Students' Attitudes: Surveys

An end-of-term paper survey was administered during the last workshop in MATH 184. In 2008, 54% of registered students responded (N = 292), whereas in 2009 it was 75% of registered students (N = 388).



...more results from student surveys



Students' Comments from Surveys

"Team work! I learn more from my group than I do from my prof in class."

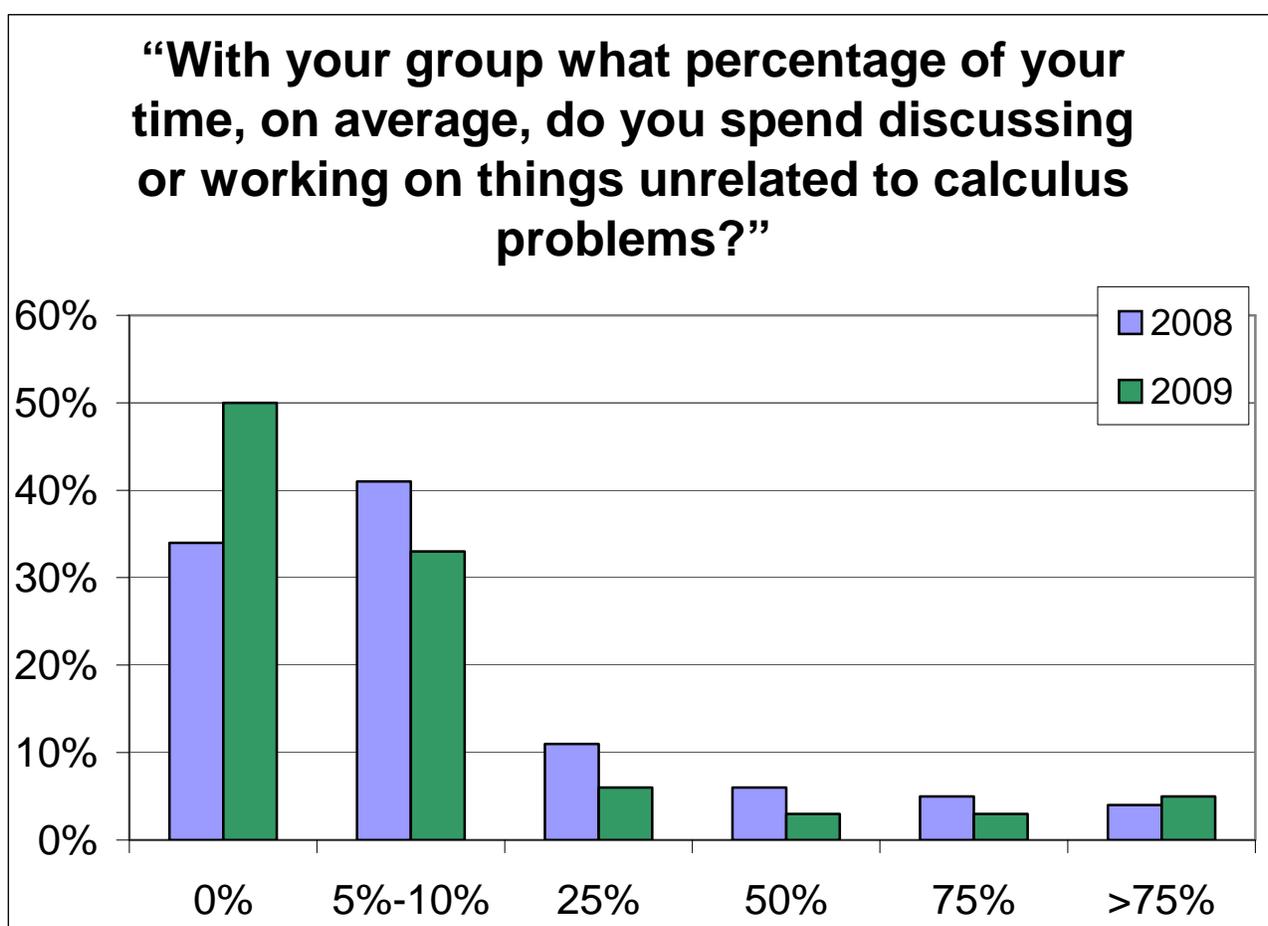
"I get practice that I would not otherwise do, with people to talk to and ask questions."

"It really helps me to understand how to do things that we learn in class properly and have a clue on how to apply them to actual problems."

2. Students' Engagement

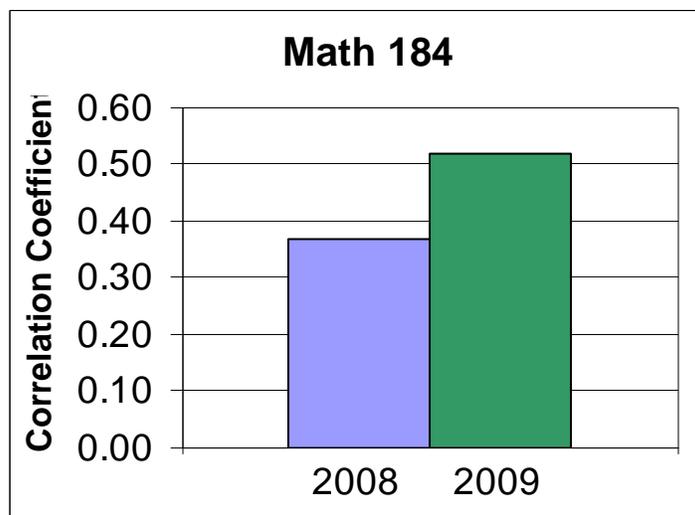
A self-reported assessment of time off-task was performed by the students about half way through the term. Consistently less students reported to be spending some time (if at all) doing things unrelated to calculus problems.

Anecdotal evidence from TAs confirmed the trend. Students seemed more engaged with the workshop activity than in the past.



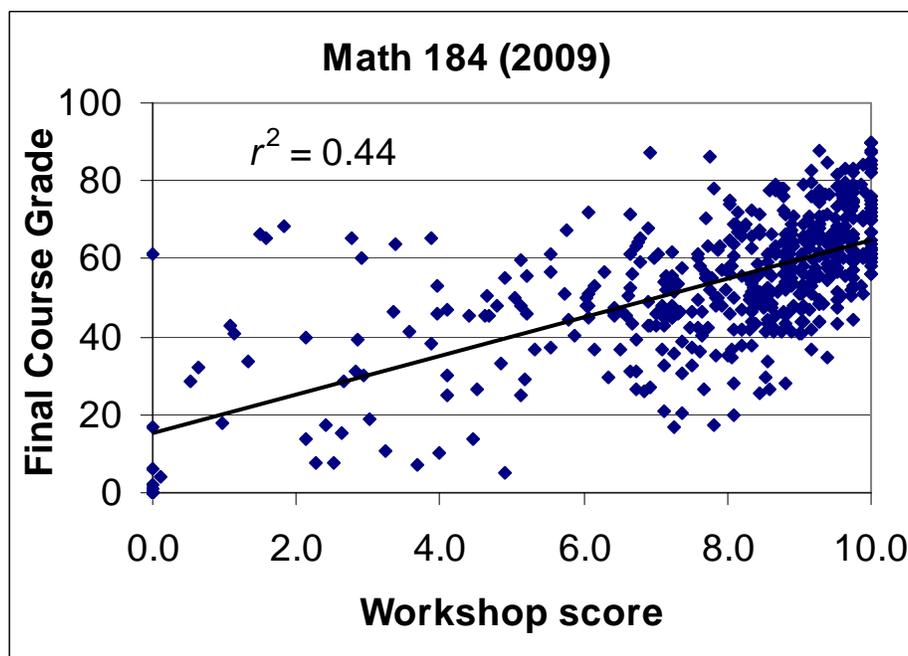
3. Correlation between Workshop Scores and Course Grades

The correlation between workshop attendance and final course grades increased noticeably in 2009.



We observed a strong linear correlation between students' performance in the workshops and overall performance in the course. Performance in the workshops was measured by the workshop score, which comprises

- attendance (12.5% of final score)
- participation (a combination of TA and peer evaluation, 37.5% of final score)
- quizzes (50% of final score)



Students' Comments from Surveys

“Team work! I learn more from my group than I do from my prof in class.”

“I get practice that I would not otherwise do, with people to talk to and ask questions.”

“It really helps me to understand how to do things that we learn in class properly and have a clue on how to apply them to actual problems.”

“Practising problems with other people helps to catch errors and prevent mistakes from becoming routine.”

“With the help from TA's I understand the concepts more easily and I learn from my mistakes”

“The most valuable thing about the workshops is the opportunity to learn from others and teach others”

Conclusions and Future Plans

Our initial observations indicated that the workshop content was lacking alignment with lectures, causing the students to lose interest and become unengaged. No individual assessment was provided to students, contributing to further time off-task for some students. The weekly production of teaching material (problem sheets and solutions) was rushed and lacking explicit learning goals, with no time allowed for revisions. In addition, the tendency of some TAs to adopt a more traditional lecturing style rather than a Socratic approach suggested that further training was needed.

In 2009 we implemented changes to address these issues, transforming the workshop program into a team effort. Meetings with the workshop coordinator, course instructors, and workshop TAs were scheduled on a regular basis; students received individual feedback on their learning in the form of weekly quizzes. A week-long production cycle of problem sets allowed for several content revisions and pedagogical improvements. These changes resulted in improved student attitudes toward the workshop program, and a higher correlation was measured between students' performance in the workshops and their grades in the other components of the course. We also observed greater consistency in the TA work across sections.

The tight production cycle of teaching material remains a challenge. Problem sets must be carefully chosen from year to year in order to guarantee alignment with lecture material. Any change in the course calendar and syllabus will result in new material to be prepared for the workshops. In the future, we plan to develop an online database of problems with solutions to ease the problem set selection and editing process.