Problem-solving Workshops in Calculus

Warren Code
Costanza Piccolo
CWSEI-Math, Department of Mathematics
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. 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.
The setting

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

- **MATH 180** – Differential Calculus with Applications to Physical Sciences and Engineering (~450 students)
- **MATH 184** – Differential Calculus with Applications to Commerce and Social Sciences (~500 students)
Workshops are ....

• problem-solving sessions
• a mandatory, weekly activity
• multi-sections with common lectures
• designed to facilitate student learning using a Socratic method
Workshop format

• Room with many blackboards:
  ~25 students  + 2 TAs
• Groups of 3-4 students
• Problem sheet for the week provided
• Work is done on blackboard
• Quiz (marked) or worksheet (marked for participation) at the end of most session
What students actually do…

They do the work:

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

Group dynamics are a factor!
2008: Issues and concerns

- Topics presented late in lecture left students with insufficient background for the workshops
- Students dissatisfied with relation of course content to workshop content
- No individual accountability
- Too much time spent off-task by students
- Problem set production too rushed
- Limited reusability of problem sets from year to year.
2009: Changes

- Clear learning goals stated on problem sheets
- Quiz at end of session to keep students on task and provide further feedback on learning
- Tight coordination of schedule and order of material between lectures and workshops
- Regular instructor meetings
- Regular TA meetings
- One Head TA for each course to keep TAs coordinated, run training sessions and feedback for other TAs, collect comments to assess problem quality
Results: Students’ Attitudes

End-of-term survey (2008: 54% of class, 2009: 75% of class)

"The workshop problems are related to material covered in class"

"The workshop problems provide useful practice for solving problems on tests"
Results: Students’ Engagement

Self reported, midterm evaluation

“With your group what percentage of your time, on average, do you spend discussing or working on things unrelated to calculus problems?”

- 0%
- 5% - 10%
- 25%
- 50%
- 75%
- >75%
Results: Correlation to course grades

Correlation between workshop attendance and course grades

Correlation between workshop score (attendance + quiz) and course grades

Math 184

Correlation Coefficient

2008 2009

Workshop score

Final Course Grade

Math 184 (2009)

$r^2 = 0.44$
Conclusions

In 2009 we implemented changes to address issues observed in previous years, 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. These changes resulted in improved student attitudes towards 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.