MATH 100 and MATH 101 Redesign

Large classes, small classes, small groups, and exams

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Skylight Open House

May 1, 2023

Outline

What are we going to talk about?

- Old structure & challenges
- Pedagogical motivation and new structure
- Student experience!? (See Kelly Paton's poster)

I've been deep into operations but now that summer is here it's time to think more about evaluation and refresh the pedagogy.

There's a lot we could talk about, so I'll stay high level until you ask.

1st year calc courses (old)

Many courses with similar material (numbers are 2021W and include W's)
Term 1 Differential Calculus

- MATH 100 (Eng & Phys Sci), 1700 students
- MATH 102 (Life Sci), 1100 students
- MATH 104 (Commerce), 1200 students
- MATH 180 (Eng & Phys Sci; 4 credit), 300 students
- MATH 184 (Commerce; 4 credit), 400 students

Term 2 Integral Calculus

- MATH 101 (Eng & Phys Sci), 1400 students
- MATH 103 (Life Sci), 800 students
- MATH 105 (Commerce), 1000 students

For example

Take MATH 101 in 2021W2 for example

- 1400 students
- 10 sections (faculty, PDF, GS instructors)
- One Instructor-In-Charge (IIC)
- Grading scheme
  - 50% final exam
  - 2 * 20% midterms
  - 10% WeBWorK (online homework)
  - Minimum 40% required on the final to pass the course

Pain-points

Instructor-In-Charge (IIC)

- We need a lot of them
- Difficult to build capacity
- The role is centralizing, but faculty have lots of responsibilities

Consistency

- Courses are equivalent credit wise
- Students register for the perceived ‘easier’ courses

Lack of communication and sense making

- Some IICs have had challenging written group assignments over the years, but mostly it’s too much to orchestrate

Administration

- Instructors should spend time on teaching but the overhead is high

Professional development

- Support for GS and PDF instructors is mixed

Goals

Pedagogical goals

- Incorporate communication and writing into mathematics early
- Emphasize modeling and application over technical theorems
- Support novice instructors (especially re active learning)
- Incorporate active learning in a structural way
- Remove weight from exams

Structural goals

- Structure needs to be sustainable and scale well
- Reduce time commitment of IIC role
- Allow instructors to focus on teaching and not administration
- Must be cost neutral

Large class, small class

1 two-hour 'large class' with a faculty member

- More theoretical (80% lecture, 20% active) class
- Large class active techniques (eg. polling, short individual work)

1 one-hour 'small class' with GS/PDF instructor supported by a UTA

- New material but active (80% active, 20% lecture)
- Group work is front and centre & sometimes manipulatives!

Lots of build up to the main stage

- Used in Vantage collage initially
- Used in smaller course (MATH 180) for several years
- Used in a single section of MATH 101
- Used in MATH 104 and MATH 105 (2021W)

May 2019 paper in PRIMUS "Small scale learning in a large scale class: A blended model for team teaching in mathematics" by Radzimski, Leung, Sargent, Prat.

2022W

MATH 100 (4500 including W's)

- 400 in the 4 credit version
- Split into three 'flavours': A (applied & phys sci) B (bio sci) C (commerce)

MATH 101 (3600 including W's)

- 11 large classes per week (8 instructors)
- 77 small classes per week (23 instructors & 37 UTAs)
- 3309 students wrote the final exam (129 with CfA)
  - Took place in 22 rooms on campus involving 78 invigilators (non-CfA)
  - Graded by 63 people over 4 days (using our in-house software Plom)

Who makes this happen?

Support staff

- Main coordinator
- Admin coordinator (web form for all student emails)
- 2 educational developers (SES, WeBWorK)

Instructional team

- 3 large class heads or ‘flavour captains’ (faculty)
- Large class instructors (faculty)
- Small class head instructor(s) (staff or GS)
- Small class instructors (GS/PDFs)
- UTAs

Support for instructors

Large class instructors are given brief ‘scripts’ each week

- Learning Objectives
- Core problems
- Poll questions
- Explicit takeaways

Small class instructors have more detailed scripts

- Learning Objectives
- Problems
- Stage directions for active learning
- Takeaways
- Scripts are discussed in weekly planning/PD meeting with small class head
- They teach the same material (to different students) 4 times per week

Course components

Grading scheme

- 50% final exam
- 20% for 5 written (typed) group assignments
  - Groups are formed in their small classes
- 10% assignments (online weekly WeBWorK)
- 10% quizzes (WeBWorK)
- 10% participation (small class and practice exams)

Final exam is split into two parts

- Part 1 'WeBWorK' portion (10 standard questions)
- Part 2 'written' portion (4 challenging questions)
- Must score 16/50 on Part 1 to pass
- Must score 25/50 on Part 1 or else get a D

Practice exams

In place of traditional midterms we use practice exams (trialed in MATH 105)

- Exam is posted and students write themselves and submit
  - We have times and rooms booked where they can write (optional)
- We grade the exam (experiments with self grading)
- Students get full marks as long as they attempt the exam
- Grades on the practice exams correlate with final exam grade ($\text{cor} = 0.57$)
- Students report less anxiety, taking it seriously, and studying (cramming) less

Signaling to students is an ongoing conversation

- In MATH 100, over 90% of students scored over 40/50 in the non-exam portion of the course (average around 45/50)
- The practice exam grade is the only signal they have about their standing in the course

Lots to think about (and do)

Data sources

- Diagnostic test data (Sept, Jan)
- Attitude 'MAPS' data (Sept, Dec, Apr)
- Experience survey data (Dec, Apr)
- Focus groups! (May)

Lots to tweak in implementation

- Curriculum (overall and flavour)
- Small class format & scripts
- PD for small class instructors
- Looking towards mastery grading

Thanks!

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