Aligning teaching methods and students learning need

Active learning vs. traditional classrooms

Calculus 1 & 2(?)

Armin Schikorra

Calculus sequence

- Calculus 1: Limits, Continuity, Differentiation, Integration
  - Fall: 16 sections á 75 students (ca. 1200 students)
  - Spring: 8 sections á 75 students (ca. 600 students)
- Calculus 2: Integration, Area/Volumes, Differential Equations, Series $\sum_{k\geq 1}$
  - Fall: 7 sections á 75 students (ca. 525 students)
  - Spring: 10 sections á 75 students (ca. 750 students)
- Calculus 3: Vectors, Geometry, Calculus in 3D.
  - Fall: 8 sections á 75 students (ca. 600 students)
  - Spring: 6 sections á 75 students (ca. 450 students)

Structure:

- MWF-classes (daytime): "standard classes" **departmental exam**
- TuTh-classes (daytime): more part-time working students, second or third attempt **departmental exam**
- evening classes: more: Pitt employees, second or third attempt, working **no departmental exam**

Exercises:

- 50 mins Tutorials (in classes of 25)
- 50 mins of Computer Lab (online homework)

Content:

- Fixed amount of sections from book.

Challenges for Calculus 1

- First year students (new to university)
- almost all science, med, engineering majors take calculus
- but some did it already at school (some can skip Calc 1)
- very heterogeneous student body (Engineers have special sections)
- Lots of material
- we don't know the majors $\Rightarrow$ only few applications tailored to students

Calculus

Date: November 06, 2019
Author: A&S Decision Support Team
Description: DR 3644210 Math DFW Rate Report
Filters: Terms 2177, 2181

SUBJECT	CATALOG NBR	Term	Enrollment	FAIL (C- & Below)	Withdrawal	Drop	Percentage Fail	Percentage Withdrawal	Percentage Drop	Percentage DFW
Calc 1	220	2181	75	27	5	12	36.00%	6.67%	16.00%	58.67%
	220	2181	74	22	2	8	29.73%	2.70%	10.81%	43.24%
	220	2181	75	15	4	9	20.00%	5.33%	12.00%	37.33%
	220	2181	76	27	9	15	35.53%	11.84%	19.74%	67.11%
	220	2181	75	19	0	4	25.33%	0.00%	5.33%	30.67%
	220	2181	75	29	3	12	38.67%	4.00%	16.00%	58.67%
	220	2181	77	15	12	22	19.48%	15.58%	28.57%	63.64%
	220	2181	77	13	7	12	16.88%	9.09%	15.58%	41.56%
	220	2181	71	9	7	16	12.68%	9.86%	22.54%	45.07%
	220	2181	75	10	2	6	13.33%	2.67%	8.00%	24.00%
	220	2181	49	12	4	15	24.49%	8.16%	30.61%	63.27%
	220	2181	75	23	4	9	30.67%	5.33%	12.00%	48.00%
	220	2181	67	6	3	23	8.96%	4.48%	34.33%	47.76%
	220	2181	74	28	3	7	37.84%	4.05%	9.46%	51.35%
	220	2181	76	9	1	6	11.84%	1.32%	7.89%	21.05%
	220	2181	73	27	3	12	36.99%	4.11%	16.44%	57.53%
Calc 2	230	2174	74	19	3	16	25.68%	4.05%	21.62%	51.35%
	230	2174	74	21	1	5	28.38%	1.35%	6.76%	36.49%
	230	2174	72	21	7	19	29.17%	9.72%	26.39%	65.28%
	230	2174	76	16	0	1	21.05%	0.00%	1.32%	22.37%
	230	2174	74	21	2	10	28.38%	2.70%	13.51%	44.59%
	230	2174	49	14	4	16	28.57%	8.16%	32.65%	69.39%
	230	2174	71	24	5	23	33.80%	7.04%	32.39%	73.24%
	230	2174	61	23	2	8	37.70%	3.28%	13.11%	54.10%
	230	2174	40	10	5	14	25.00%	12.50%	35.00%	72.50%
	230	2174	42	14	1	11	33.33%	2.38%	26.19%	61.90%
Calc 3	240	2181	75	5	2	4	6.67%	2.67%	5.33%	14.67%
	240	2181	66	18	0	9	27.27%	0.00%	13.64%	40.91%
	240	2181	56	3	2	13	5.36%	3.57%	23.21%	32.14%
	240	2181	70	7	0	3	10.00%	0.00%	4.29%	14.29%
	240	2181	75	12	1	3	16.00%	1.33%	4.00%	21.33%
	240	2181	76	13	1	4	17.11%	1.32%	5.26%	23.68%
	240	2181	73	5	3	6	6.85%	4.11%	8.22%	19.18%
	240	2181	46	13	2	13	28.26%	4.35%	28.26%	60.87%

- All universities of similar standing seem to have comparable DFW-rates/struggles
- ideas to improve:
  - smaller class sizes (George Mason U)
  - "extended calculus" (2 semester Calculus 1 classes)
  - active-learning calculus (usually smaller classes).
- data supporting active learning in Calculus at University level is shaky (comparsion with previous years, other instructors etc.)
- anectdotally: some students profit strongly from active-learning, some students "hate it" ($\neq$ not profit?)

Our approach

- **Assumption:** Not all students profit from active-learning calculus, but some do, we would like to know who and offer them an option
- **Assumption:** Students need to be (gently?) forced to practice early

Active learning:

- students receive material before each week (videos, texts)
- a substantial part of class is transformed into group work on practice problems

Things that happened/happen

- Fall 2018: Calculus 1
- Recovery phase/reuse of material/plan for data analysis
- Fall 2020: Calculus 2?

Calculus 1, Fall 2018

setup

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- 75 pages of problems prepared
- exam-like & (few) more conceptual

groups

- groups of 3 or 4.

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- 1 instructor, 1 TA, 2 UTAs

Layout

active-learning layout

Mo/We	Fr	Tu	Th
75 stud.	75 stud.	(unchanged)	75 stds
mini-lect. (10 min)	summarizing lect.		videos
group work (40 min)			
1 TA 1 UTA	0 TA 0 UTA	1TA/25ppl.	1 TA/75 ppl

Assessment

current assessment

Ca. 10 Quizzes	online hw	Midterm 1, 2	Final
10%	10%	25%	30%
instructor	departmental	instructor	departmental cumulative letter grade ± 1

Material

- All material available to both (active learning and traditional learning)
- Problem sets & videos available **after** the week for non-flipped

videos

- Lightboard (thanks to Sera Thornton)
- also posted available online videos (as "further reading/preparation")

Some numbers

average

	P	M1	M2	Final
9am, flip, A.	77.61	75.85	62.07	62.44
11am, nonflip, A.	71.09	70.46	60.96	62.16
12am, flip, T., ENG	82.29	82.21	65.18	70.24
1pm, nonflip, T., ENG	73.83	82.23	69.34	72.92

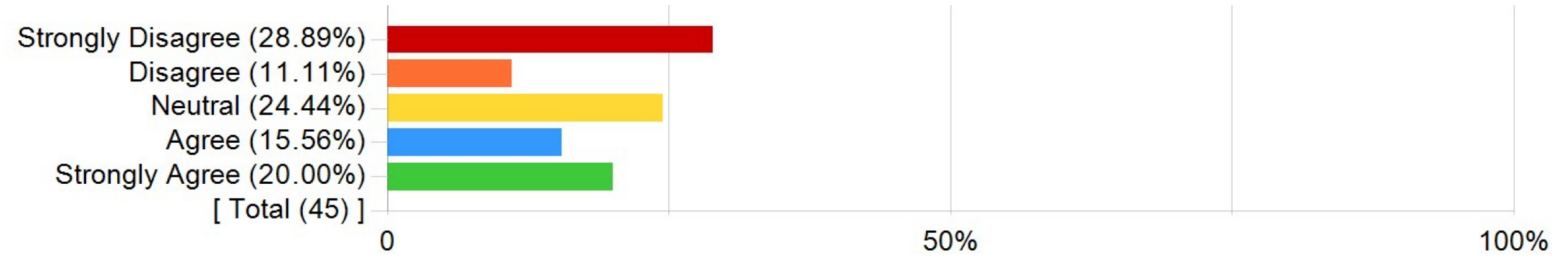
P - Pretest; M1, M2 - Midterms;

median

	P	M1	M2	Final	Drops
9am, flip, Armin	81	78	67	65.34	1
11am, nonflip, Armin	75	73	63	66.48	11
12am, flip, Tom, ENG	84	85	67.5	70.55	1
1pm, nonflip, Tom, ENG	74	83	70.5	74.5	2

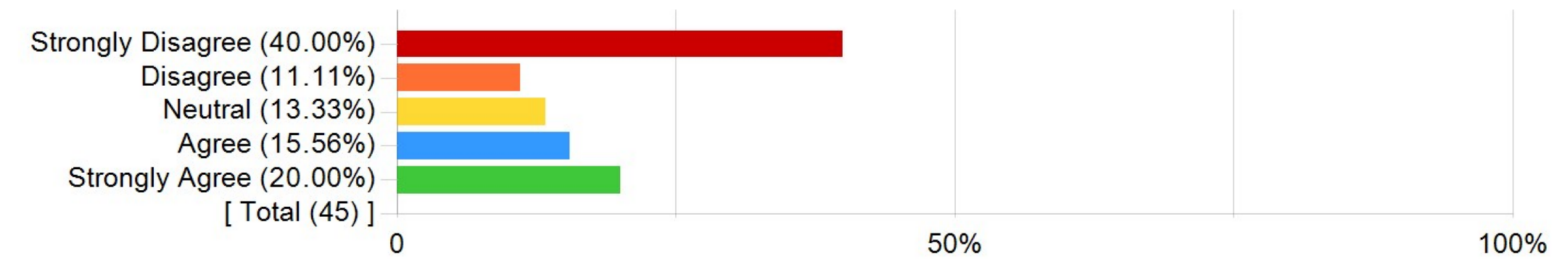
Evaluations (A.S.)

I like the flipped classroom teaching style



Statistics	Value
Mean	2.87
Standard Deviation	1.50

I would like my future calculus courses to be a flipped classroom



Statistics	Value
Mean	2.64
Standard Deviation	1.61

Fall 2019, integrated version

- material integrated in class, think/pair-model to work on practice problems, but no "force" to read ahead.
- very comparable results.

Issues:

- prior knowledge is very inhomogeneous, so in work sessions some students are bored, some are completely lost.
- students seem to struggle with many concepts of university, self-eficacy sometimes low, no study groups

Calculus 2 in 20/21? Goals

pending Provost's course-incubator approval.

- to untangle the data "struggling with first semester of college" from "struggling with calculus"
- almost everybody is new to Calculus 2 topics
- everybody (who did not take AP Calculus) has passed Calculus 1
- develop eventually material for whole Calculus sequence.
- being able to monitor (eventually) long-term active-learning effects (if you hate it in Semester 1, don't take it in Semester 2)
- Analysis by the group of Chris Schunn.