Restructuring Calculus: Reorganizing Content and Moving Toward a Flipped Classroom

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Calculus at KU

The courses in the calculus sequence at KU consist of MATH 125, 126, and 127. These courses meet five times a week:

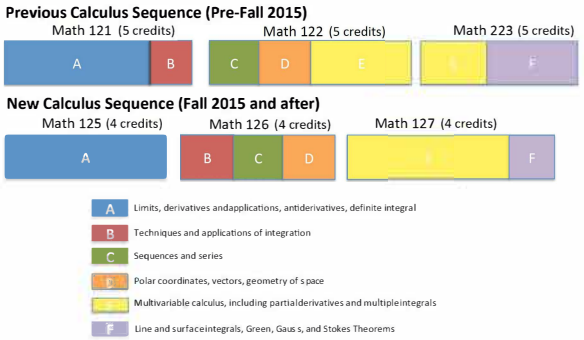
- Three large lecture sessions with the professor, and
- Two discussion sessions with a graduate student.

Typical enrollment per semester is 150 to 300 students. While exams are a large part of a student's final grade (70-80%), students complete many formative exercises before exams are taken, including:

- Online assignments and written homework (10-15%)
- Participation in quizzes and recitation (5-10%), and
- Lecture participation through iClickers (3-4%).

Restructuring the Calculus Sequence

The largest change to the calculus courses was re-grouping of the content between the three calculus courses:

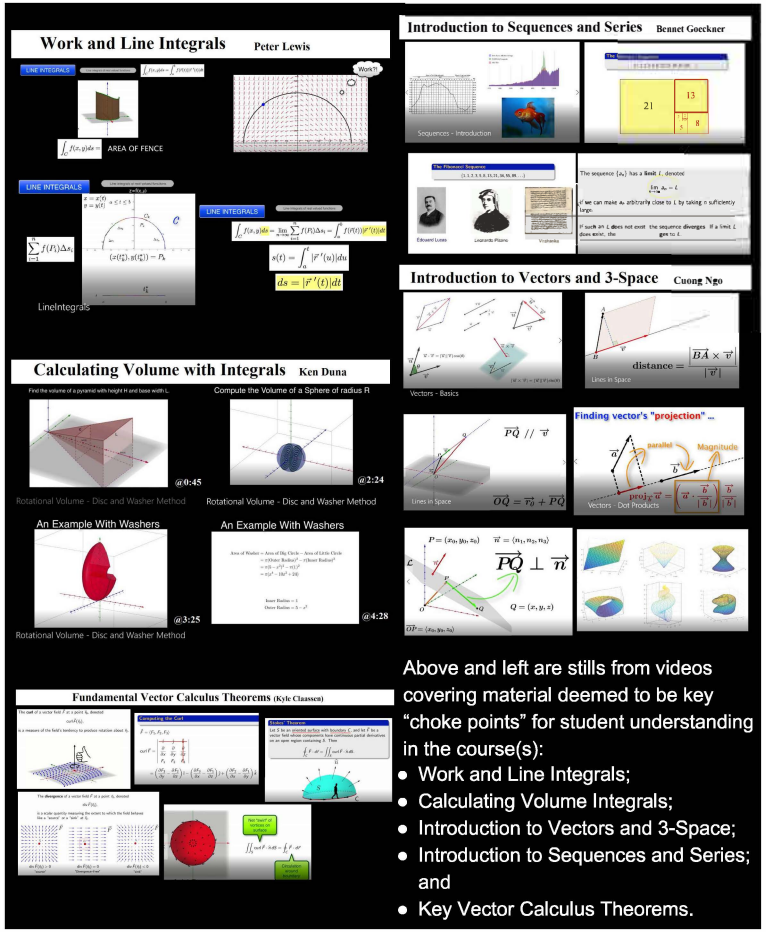


In addition, the following major changes were implemented in the classroom:

- Created uniformity of course content and materials
- Incentivized lecture participation and attendance with iClicker questions and GTA presence in the class
- Outlined well defined learning objectives for each section and module and ensured assessments are constructed in-line with objectives
- Conducted greater coordination of GTAs through weekly meetings, peer observation, collaborative exam creation, guidance on leading active classrooms, and creation of a course specific handbook
- Utilizing videos created by GTAs for a video library for use in a flipped classroom environment, and
- Extending uniformity to discussion sessions, with additional and continuing training for GTAs.

A Video Library of Mathematical Methods

Brennan has created a full video library for MATH 125 consisting of 35 pre-lecture videos and four post-lecture videos (each video being 5-10 minutes long). Each video is paired with a short quiz online quiz, due before each lecture begins.



Above and left are stills from videos covering material deemed to be key "choke points" for student understanding in the course(s):

- Work and Line Integrals;
- Calculating Volume Integrals;
- Introduction to Vectors and 3-Space;
- Introduction to Sequences and Series; and
- Key Vector Calculus Theorems.

Redesign Results to Date

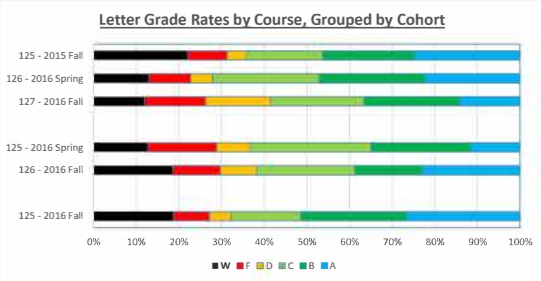
Drop, failure, and withdrawal rates prior to the redesign of the courses (pre-Fall 2015) ranged from 16.3 to 45.9% for Calculus 1 (MATH 125) and 17.7 to 47.9% for Calculus 2 (MATH 126).

D/F/W Rates by Cohort

	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012
Calculus 1	45.9	30.1	43.7	35.4	47.9	38.4	26.9	18.4
Calculus 2	47.6	33.1	31.9	37.9	42.6	17.8	38.9	17.7

	Spring 2013	Fall 2013	Spring 2014	Fall 2014	Spring 2014	Fall 2015	Spring 2016	Fall 2016
Calculus 1	42.2	16.3	35.7	26.7	22.6	35.9	36.7	32.2
Calculus 2	36.8	39.6	44.0	30.3	44.0	27.8	38.3	TBD

Student grades post-redesign show the majority of students (generally greater than 60% for most semesters) attain a letter grade of C or above in MATH 125, 126, and 127.



Acknowledgements

Funding from CTE provided resources to expand the video library with GTA generated content for MATH 126 and 127.

GTA video creators include:

- Ken Duna MATH 126 Videos -
- Bennet Goeckner MATH 126 Videos -
- Cuong Ngo MATH 126/7 Videos -
- Peter Lewis MATH 127 Videos -
- Kyle Claassen MATH 127 Videos -