Team-Based Learning

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Outline

1. Team Based Learning Basics
2. Projection Components
3. Recent Research
   - Quantitative
   - Qualitative

Components of Team-Based Learning

1. Flipped classroom:
   - Content divided into modules
   - First exposure via readings/videos outside of class

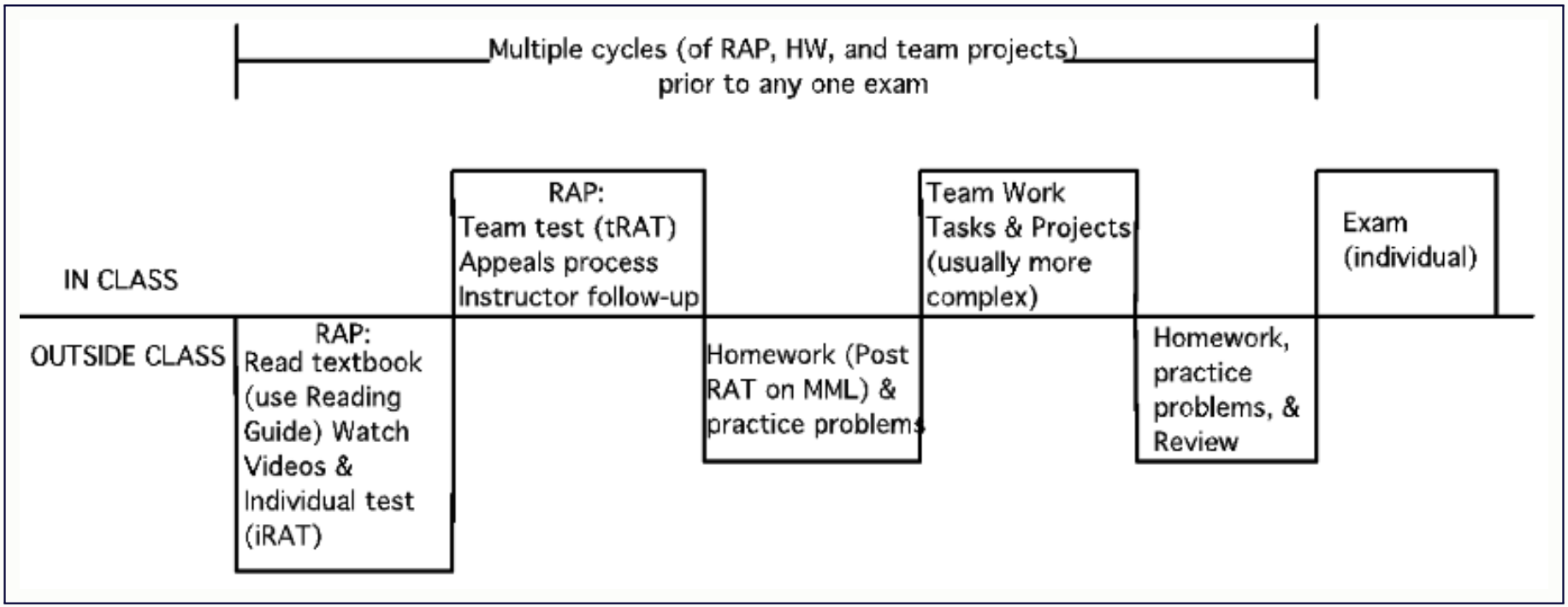
2. Readiness Assurance Process
   - Individual readiness assessment (IRAT)
   - Team readiness assessment (TRAT) to ensure mastery of the basic material
   - Performance on IRATs/TRATs counts toward students' grades and allows the instructor to determine what material requires review

Components of Team-Based Learning

3. Student Teams
   - Permanent, hetrogeneous teams of 5 to 7 students
   - Minimize isolation of women and minority students
   - Collaborate on demanding in-class activities

4. Application Activities/Projects
   - Following the readiness assurance process, teams apply their knowledge to more complex problem-solving activities
   - Projects are NOT practice problems but new problems students have never seen worked

Course Structure

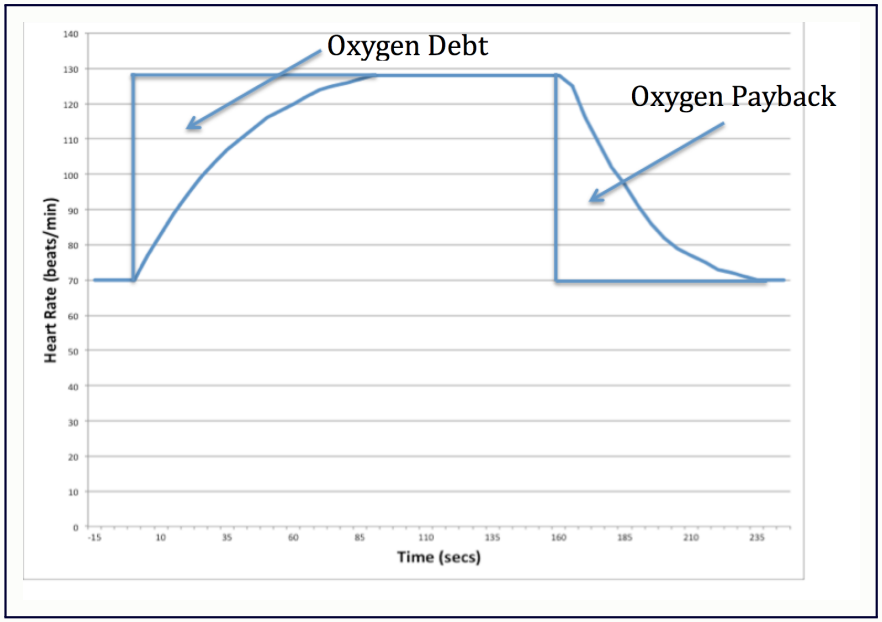


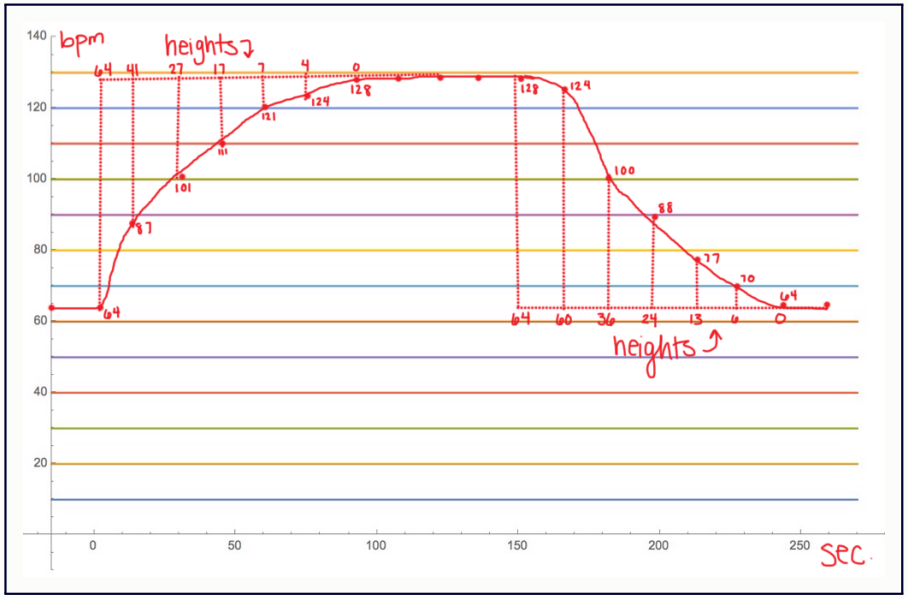
- Instructor/TA assistance for in-class activities
- Adapted for a Calculus course from the traditional TBL structure

Project Components

- Emphasize underlying concepts and applications
- Require higher-level thinking skills: analyzing, creating, and evaluating
- Demand the intellectual capital of the entire group; require high levels of both thinking and effort from the team
- Promote a spiral review of concepts and procedures

Project Example: Oxygen Debt

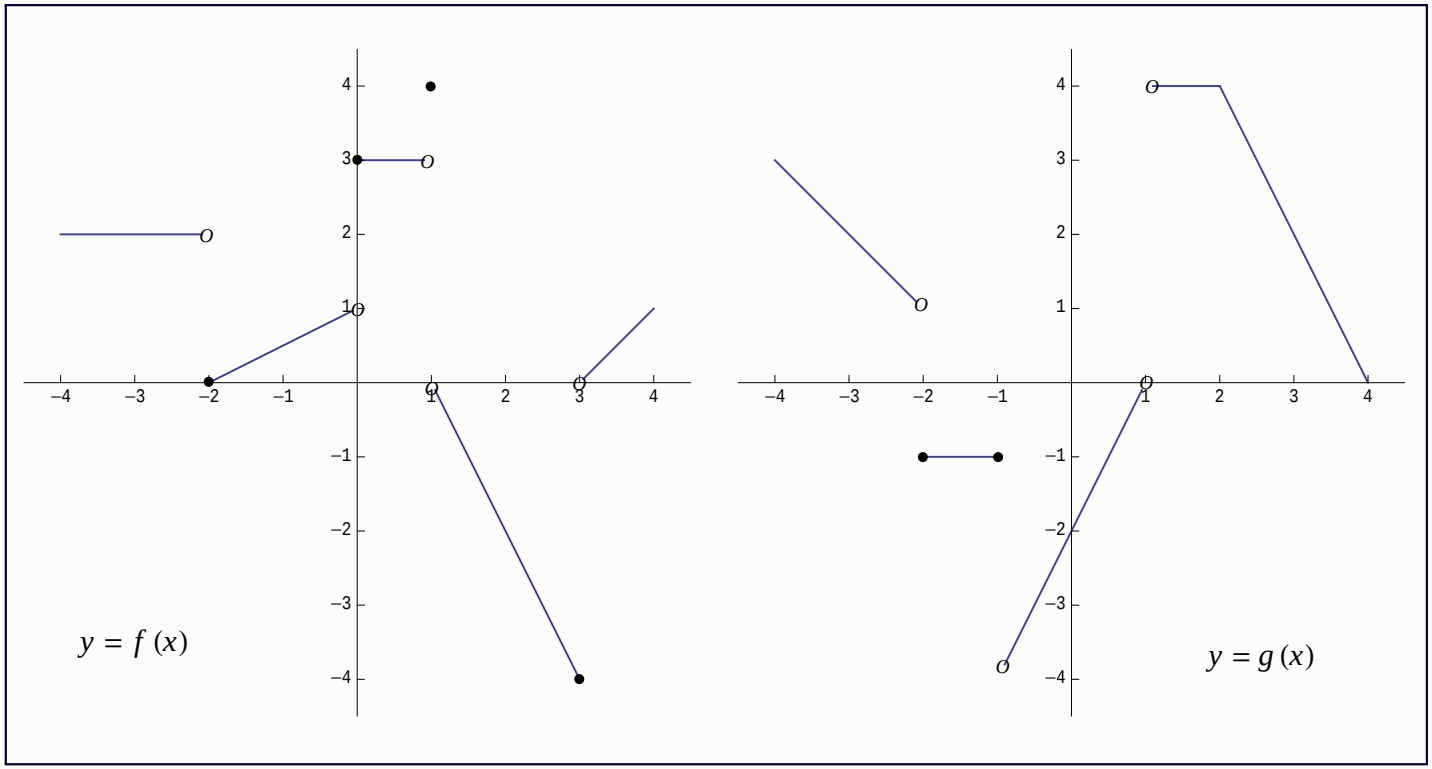




Important Features

- Application activity: requires students to interpret and analyze given content and place it in a mathematical setting
- Relies upon conceptual understanding of a Riemann Sum as an area approximation

Project Example: Limits



Find each of the following:

$$\lim_{x \to 1} (f(x) + g(x))$$

$$\lim_{x \to 1} (f(x) \cdot g(x))$$

Important Features

Conceptual understandings: Is it possible for the sum of limits to exist without the individual limits existing? What about the product? How do we know that a limit exists? How do you justify this?

Calculus at Iowa State University

- Large (about 36,000 students) Midwestern Research I institution: 43% women, 11% US minority, 12.6% international
- Mainly large lectures (100-300) with weekly recitations (25-35)
- TBL implemented in select Calculus I and II sections

Quantitative Results: 2016 Calculus 1 Final Exam

- Bolles, Peters, Johnston, Holme, Ogilvie, Bozeman, Seitz, Wang (2018)
- 1845 students in Calculus I for science/eng. in Fall 2016
- Uniformly-graded departmental midterm, final exams.
- Three instructors taught 366 students using TBL (N = 277 students across two large classes and N = 62 students across two small classes).

TBL			Non-TBL		
Mean	SD	N	Mean	SD	N
55.52*	21.88	325	50.05	21.89	851

Table: Note: $^*p < 0.001$

Quantitative Results: 2016 Calculus 1 Final Exam

Quartiles according to Incoming Competency Scores

- Based on Calculus Concept Inventory, ALEX placement scores, and AP Calculus Test Scores
- Mean ICS within .1% for TBL and Non-TBL students

	TBL			Non-TBL		
	Mean	SD	N	Mean	SD	N
Q1	**37.4**	21.1	57	36.9	20.3	62
Q2	**51.6**	16.5	52	44.4	20.6	58
Q3	**58.2**	18.3	80	53.2	20.6	47
Q4	**62.2***	18.9	50	53.2	21.7	34
Q5	**74.3***	17.6	40	60.3	24.4	29

Table: Note: $^*p < 0.05$

Quantitative Results: 2016 Calculus 1 DFW Rates

Fall 2016	TBL	Non-TBL
Overall	**19.1***	32.0
Female only	**24.7**	30.1
Ethnic Underrepresented only	**34.8**	45.5

Table: Note: $^*p < 0.01$

Qualitative Study: Preliminary Results

Low-quality student engagement and social interactions, however, can hinder the positive effects of TBL (Schultz et al., 2010).

- Motivated from polarized student reactions
- Spring 2018 TBL Calculus II: two large lectures and one small section
- Two waves of intensive student interviews

Motivation Theory

Self Determination Theory of Motivation (SDT; Deci and Ryan, 1985), (Ryan and Deci, 2000)

- Competence: An individual's self-efficacy, or belief that they can be successful within a particular environment
- Relatedness: The need for secure and satisfying social connections with other people
- Autonomy: The ability to initiate and control one's actions

Individuals are motivated to engage in environments that facilitate the satisfaction of these three basic needs (Deci et al., 1991).

Preliminary Results

The results provide initial evidence that students' engagement in a TBL calculus course was closely related to their perceptions of the environment as supporting or thwarting the fulfillment of their psychological needs (Baker, Seitz, Bolles, 2018).

Needs Supportive

- **Relatedness/Competence**: social team support
- **Competence**: collaborative team interactions
- **Autonomy**: student control of strategy in using the videos and or/text
- **Competence**: adjusting strategy based on performance

Needs Thwarting

- **Relatedness/Competence**: unequal academic contributions
- **Competence**: use of shallow learning strategies; attribution of lower performance to ability rather than strategy
- **Autonomy**: high structure of out-of-class learning

Future Directions

These findings imply that educators can support student engagement in TBL by

- encouraging high-quality student collaboration, explicitly teaching and reducing time pressure
- providing scaffolding for self-paced learning
- communicating the rationale of course requirements

Thank you!

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