The impact of blended learning pedagogy on students' perception and performance in undergraduate biology

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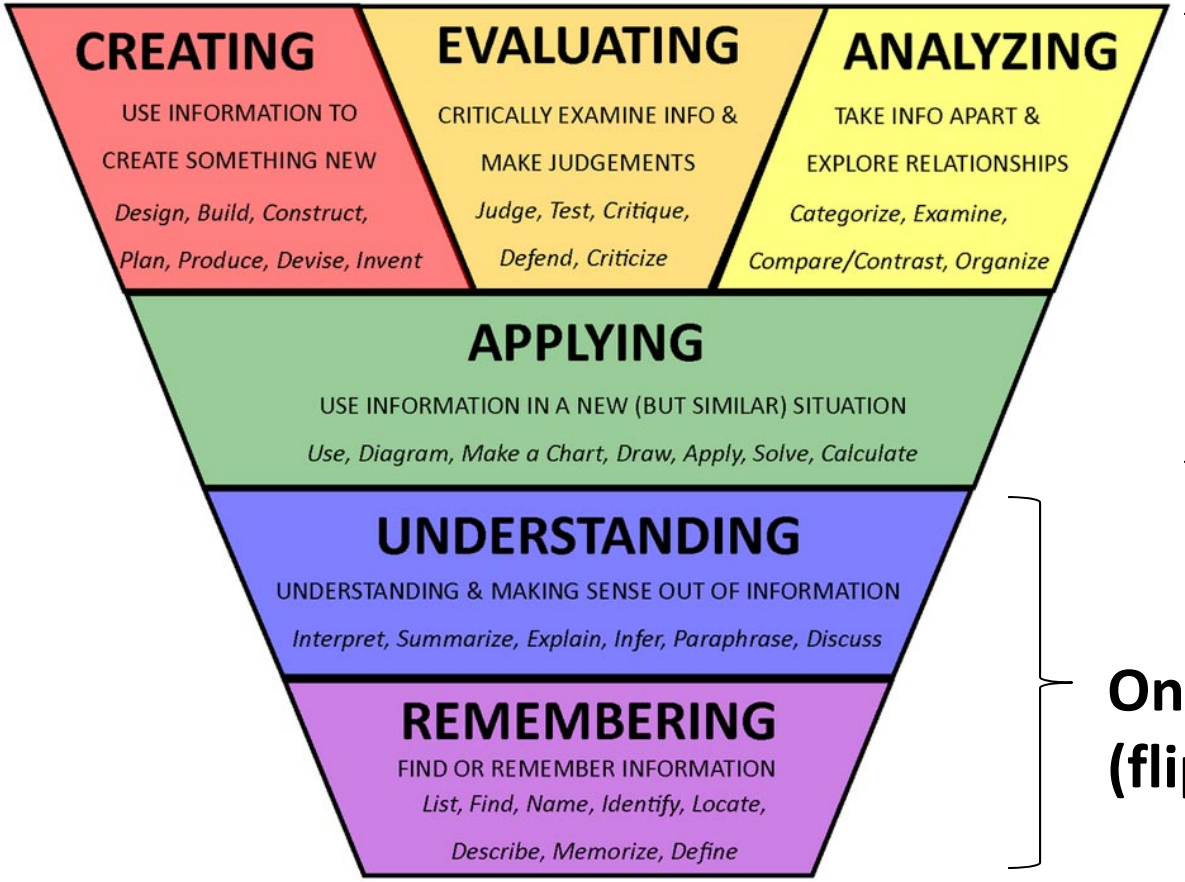
Challenges in Teaching Biology

- Lack of motivation to study Bio
- Wrong perception about Bio course
- Diverse pre-univ Bio background

Our Solution: Blended Learning (including flipped classroom, lecture, lab, virtual lab, classroom activities, real-life examples etc.)

Blended Learning & Bloom's Taxonomy



Face-to-face teacher/student interaction

Online-learning (flipped classroom)

Paradigm Shift

Roles & Expectations

Students MUST take responsibility: *ownership of learning*

Teachers MUST take *facilitation*

Materials & Methods

10.012 Introduction to Biology

Learning Objectives

1. Describe the key concepts in cellular biology and genetics.
2. Apply these fundamental concepts to explain the function and regulation of living systems.
3. Describe **common laboratory techniques and methods of data analysis** used in cellular biology and genetic research.
4. **Interpret biological experimental data** using qualitative and quantitative analysis.

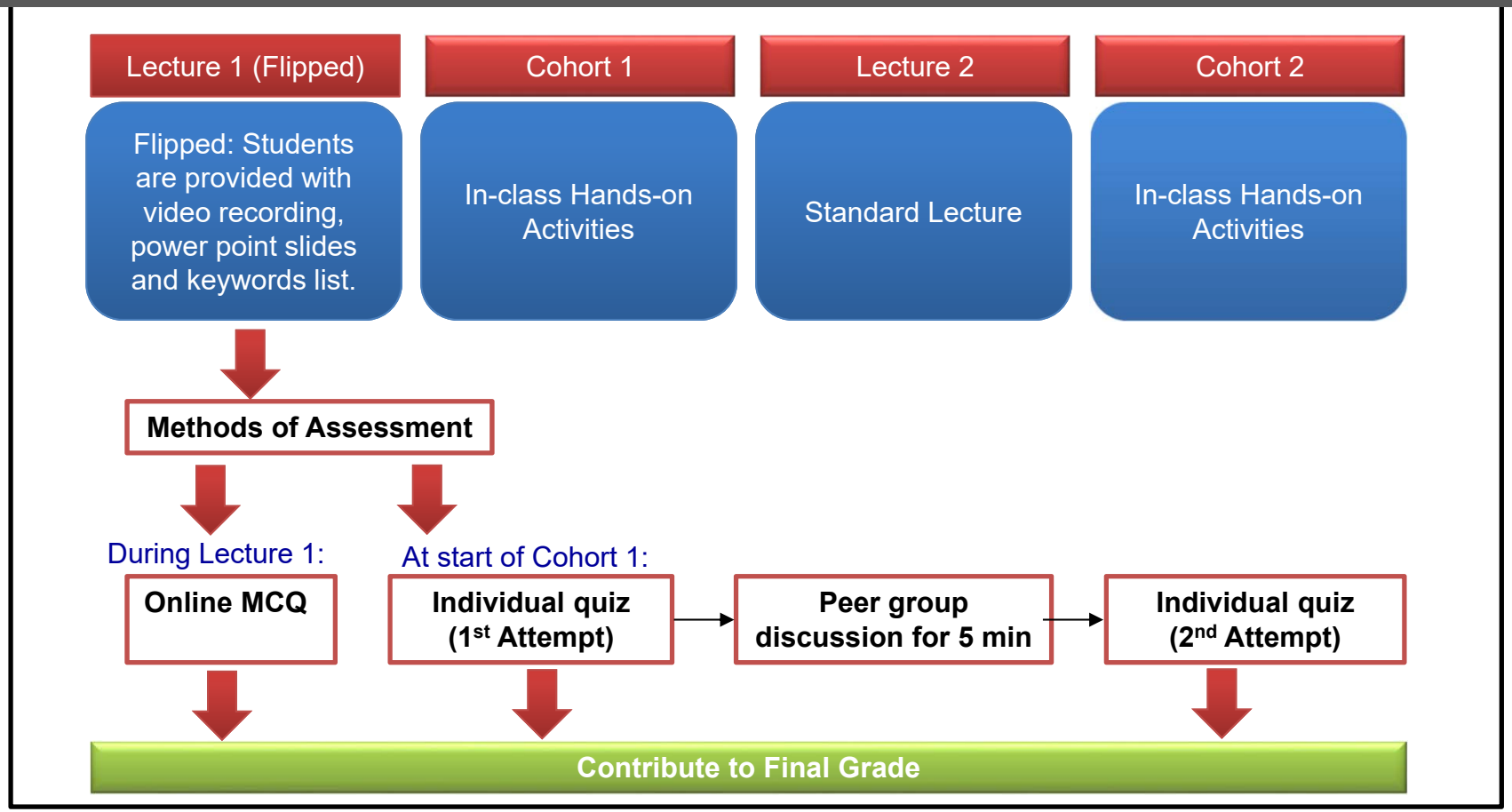
Time Commitment

A half-term subject, from week-8 to week-14.

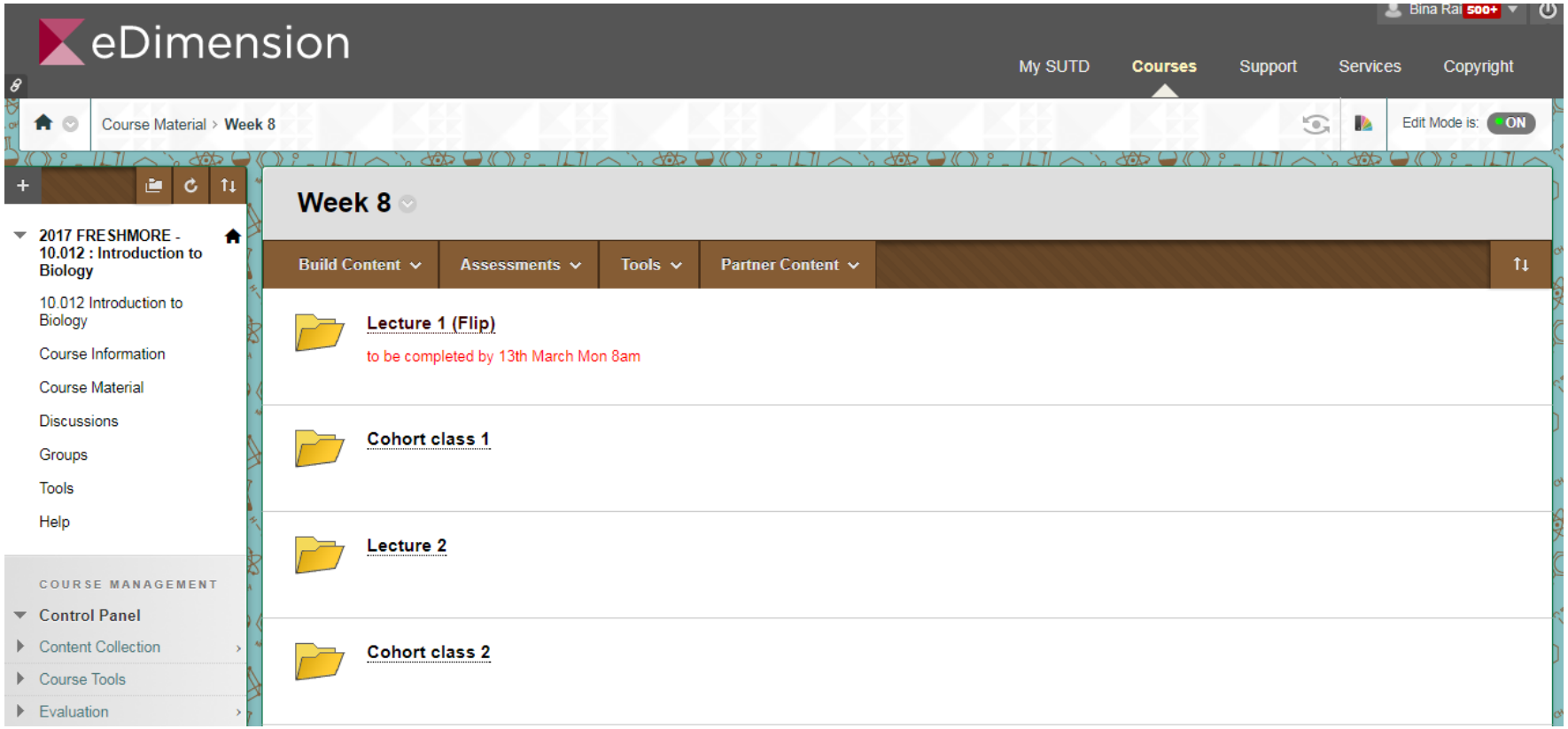
It takes **12 hours per week**, divided as follows:

- 1h of flipped classroom
- 1h of standard lecture
- 2hx 2 cohort classes
- 6h of self-study (reading and problem sets etc.).

Weekly Schedule of Blended Learning with Flipped Classroom Approach for Teaching “Introduction to Biology”.

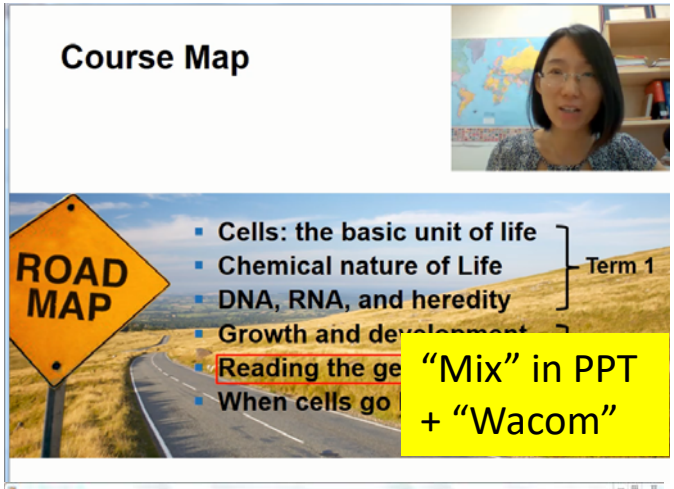


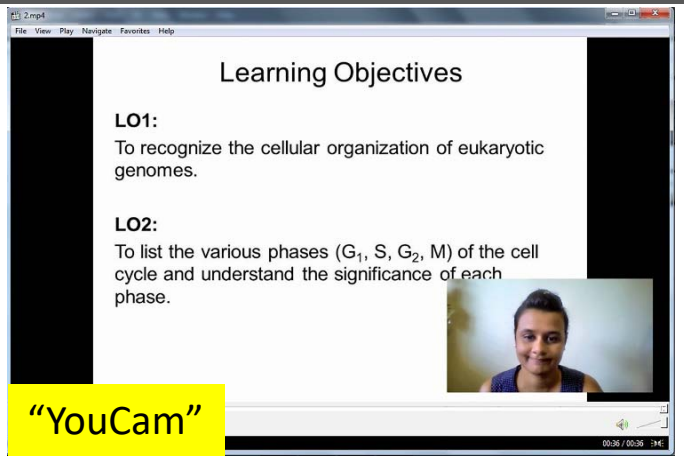
Use Blackboard to Organize Course Material

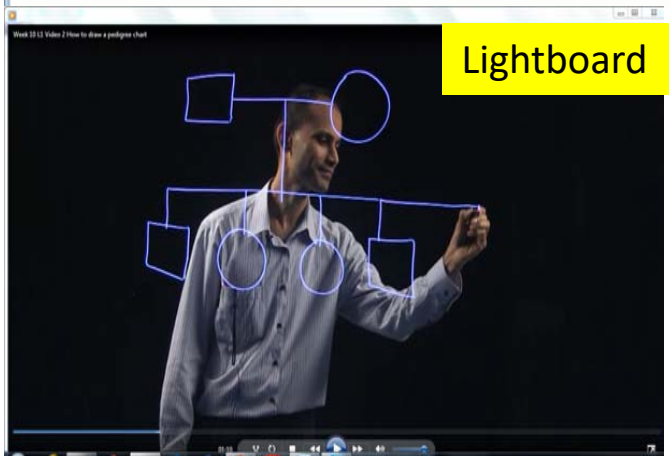


Lecture 1 (Flipped)

Flipped Classroom







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Online MCQ

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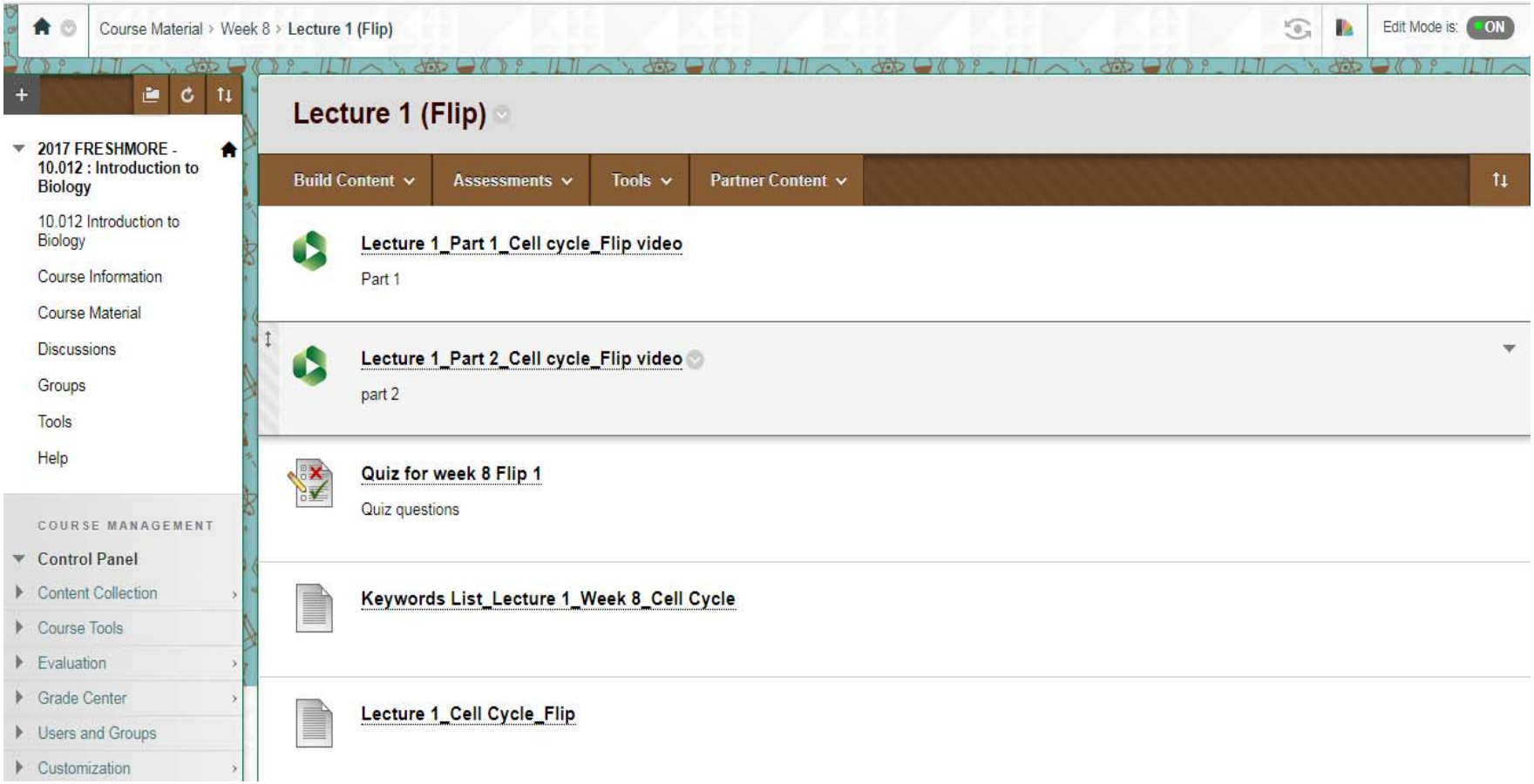
PowerPoint Slides

\+ Keywords List

Course Material of Lecture-1 (Flip)



Lecture 2

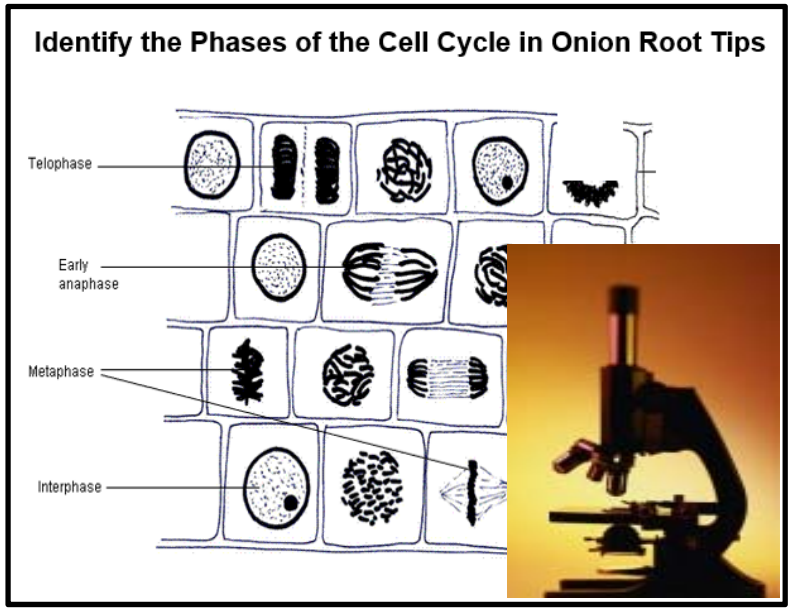
Standard Lecture

- 1h/week
- 250 students/lecture
- Using Clicker Questions
- Using Think-Pair Share
- Demonstrations
- Guest Lecture

Cohorts 1 & 2

In-class Hands-on Activities

Real Lab



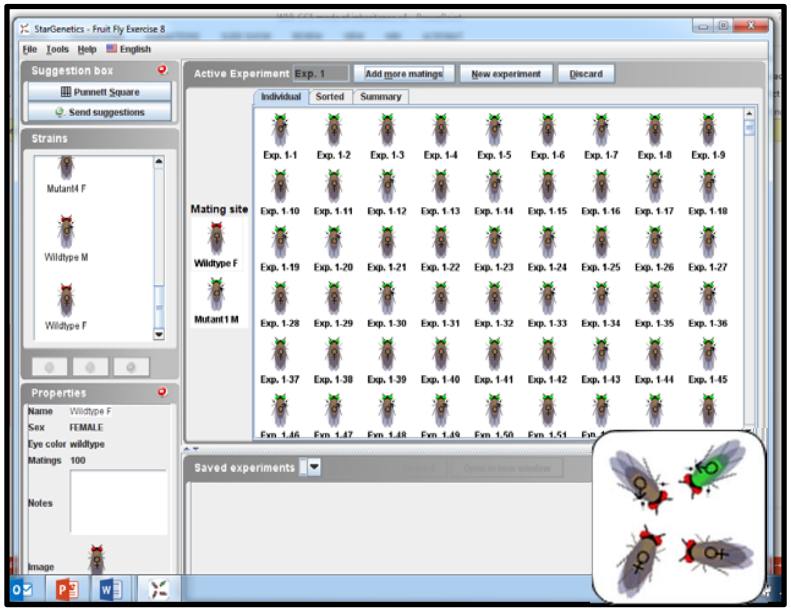
Virtual Lab (StarCellBio)

MIT
https://starcellbio.mit.edu/

Cohorts 1 & 2

In-class Hands-on Activities

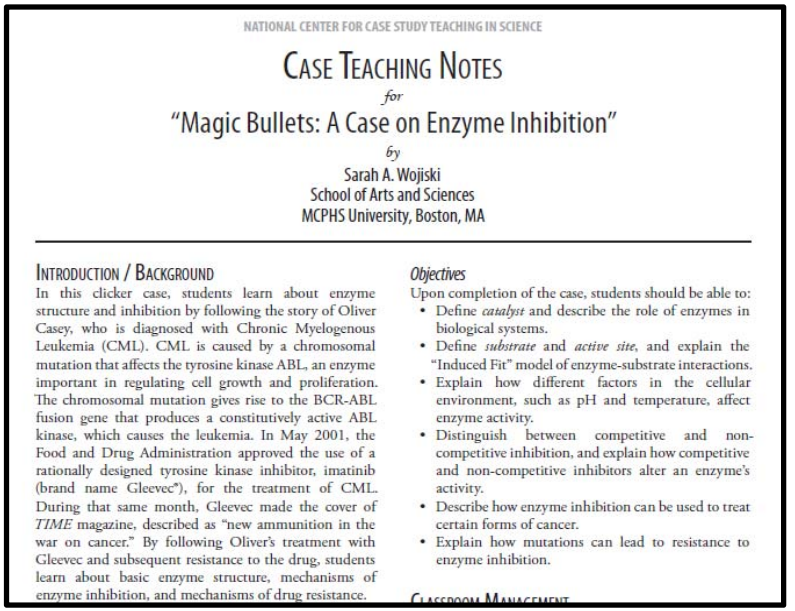
Virtual Lab (StarGenetics)



MIT

http://star.mit.edu/genetics/

Case Studies



NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

CASE TEACHING NOTES

for

"Magic Bullets: A Case on Enzyme Inhibition"

by

Sarah A. Wojiski
School of Arts and Sciences
MCPHS University, Boston, MA

INTRODUCTION / BACKGROUND

In this clicker case, students learn about enzyme structure and inhibition by following the story of Oliver Casey, who is diagnosed with Chronic Myelogenous Leukemia (CML). CML is caused by a chromosomal mutation that affects the tyrosine kinase ABL, an enzyme important in regulating cell growth and proliferation. The chromosomal mutation gives rise to the BCR-ABL fusion gene that produces a constitutively active ABL kinase, which causes the leukemia. In May 2001, the Food and Drug Administration approved the use of a rationally designed tyrosine kinase inhibitor, imatinib (brand name Gleevec®), for the treatment of CML. During that same month, Gleevec made the cover of *TIME* magazine, described as "new ammunition in the war on cancer." By following Oliver's treatment with Gleevec and subsequent resistance to the drug, students learn about basic enzyme structure, mechanisms of enzyme inhibition, and mechanisms of drug resistance.

Objectives

Upon completion of the case, students should be able to:

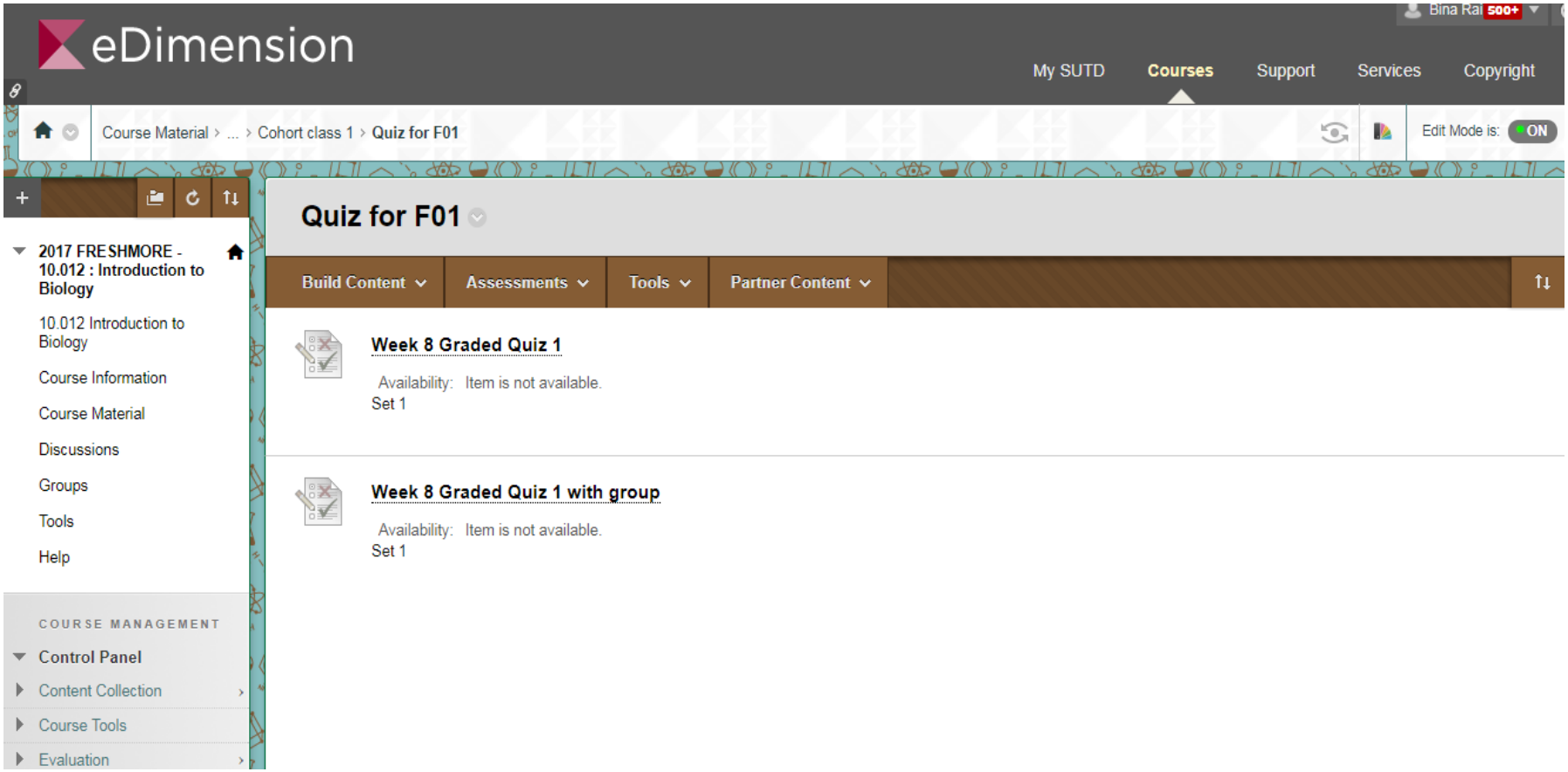
- Define *catalyst* and describe the role of enzymes in biological systems.
- Define *substrate* and *active site*, and explain the "Induced Fit" model of enzyme-substrate interactions.
- Explain how different factors in the cellular environment, such as pH and temperature, affect enzyme activity.
- Distinguish between competitive and non-competitive inhibition, and explain how competitive and non-competitive inhibitors alter an enzyme's activity.
- Describe how enzyme inhibition can be used to treat certain forms of cancer.
- Explain how mutations can lead to resistance to enzyme inhibition.

CLASSROOM MANAGEMENT

University of Buffalo

http://sciencecases.lib.buffalo.edu/cs/collection/

Quiz (Cohort-1, before & after discussion)



Results-I: Students' Perception

General Feedback about Course

	Overall Rating
The course has stimulated my interests to learn more about the subject.	4.0 /5
The course has improved my knowledge in the subject.	4.1 /5
The course is well organized and structured.	4.0 /5
The course work load is manageable.	4.0 /5
The modes of assessment reinforce the learning of the course materials	4.0 /5
Overall, I would rate this course as: Very Good/Good/Average/Below Average/Poor	4.0 /5
The course actively involved me in learning experiences.	4.1 /5
After going through all the classes and assessments (quizzes, tests, assignment, design projects, exams, etc.) I am confident that I have achieved the measureable outcomes of the subject.	4.0 /5

Course Feedback _ Strengths

"It is good that they give us a lot of ***resource*** as well as ***case studies*** and ***real experiments*** to let us understand better, this really enhance the learning experience and should be kept for future batches. The videos were good too just that it should be slightly more comprehensive."

"***Well structured and catered to the interests of the general student population*** that have not learnt about the subject before. Provides a good insight into a subject that we otherwise would not have an opportunity to learn about."

"Highly ***interactive*** course. Online Quizzes and ***Flip Classrooms*** are interesting and helpful."

"Very ***interesting and engaging*** subject, taught well."

Course Feedback_ Weaknesses

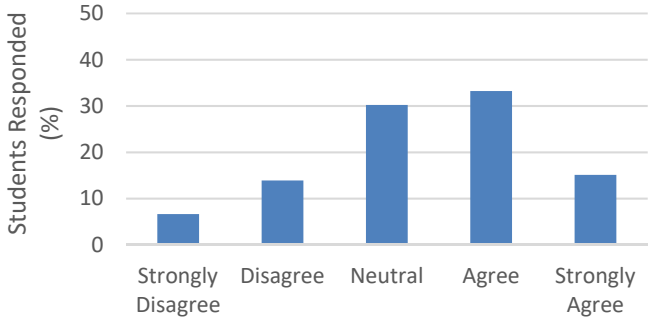
"Too much of the content was touch-and-go, too brief to craft a lasting and thorough understanding of the course materials which was relatively disappointing. Furthermore, the learning objectives did not adequately explain the depth to which we should delve into to understand the lesson material which could only be done if everything was correlated and taught with flow, instead of the abrupt manner that biology concepts are explained to us, without much linkages to other disciplines as well.

"Course well structured, through some weeks are very content heavy and some less, would be better if the content was more balanced each week to make it easier for us to memorize. "

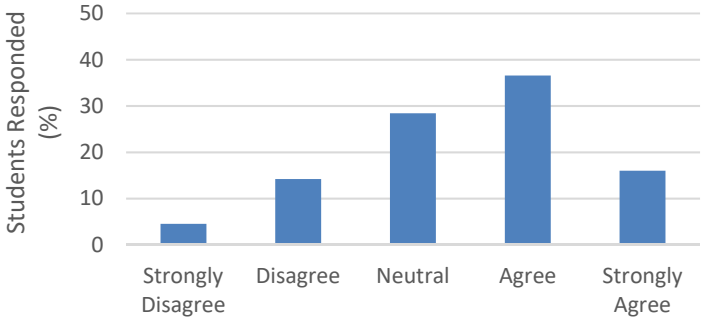
"Too much depth within such a small amount of time."

Specific Feedback on Flipped Classroom

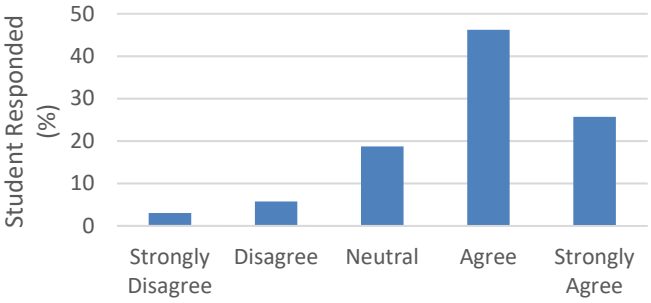
Q1: I like to watch/study the flipped lessons outside the classroom.



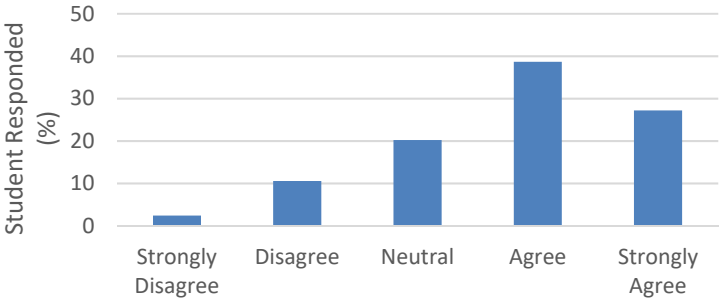
Q2: The flipped classroom is more engaging than the traditional lecture in the lecture hall.



Q3: Having the lessons flipped gave me sufficient time to learn the fundamentals at my own pace.

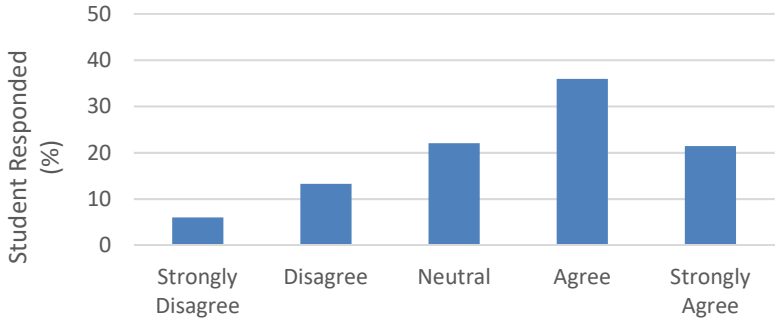


Q4: The flipped lessons helped me schedule my learning during my most alert time of the day.

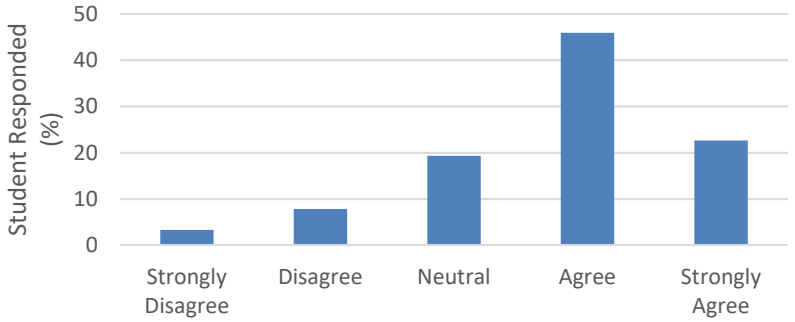


Specific Feedback on Flipped Classroom

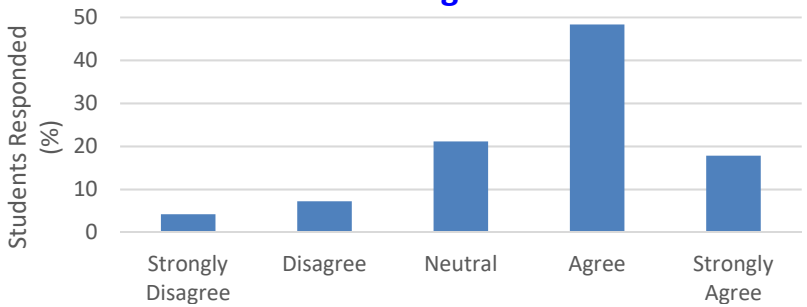
Q5: Having flip lessons over the weekend helped me systematize my weekend studying, and lessened the strain during the weekday.



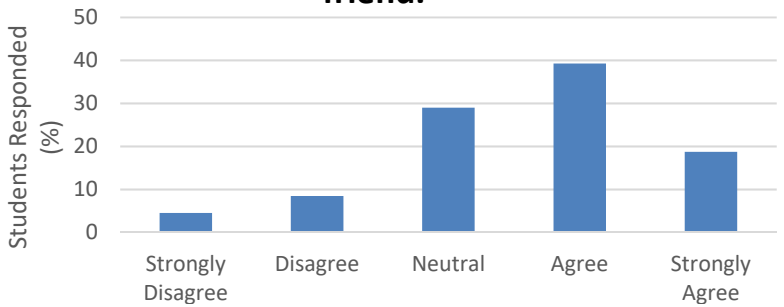
Q6: The flipped classroom provided me the necessary background knowledge to be prepared for the cohort exercise of the week.



Q7: The flipped classroom freed up the cohort time for active learning exercises.



Q8: I would recommend the flipped classroom to a friend.



Specific Feedback _ Positive Responses

It is good because I can do it ***anytime of the day*** and can do it when I feel like it.

Quiet interesting and engaging. Gives good background knowledge before class

You can always ***rewind the video*** if you missed out on important slides (which allows taking notes much easier)

Having ***quizzes*** after going through flipped lessons test my level of understanding much more than clicker questions in lectures.

Flipped lessons are the best.
You don't have to waste time waiting for everyone to settle down in a LT.
You don't have to squint your eyes to see what is written on the board if you aren't sitting at the front.

All lectures should be flipped as conventional lectures are very boring and very distracting as there are many people talking in the lecture theatre.

Specific Feedback _ Negative Responses

I feel that flipped classrooms seems to be an additional ***workload*** to be added during the weekend which may not be ideal for learning, especially with the other workload to be considered. it becomes an additional homework that needs to be done.

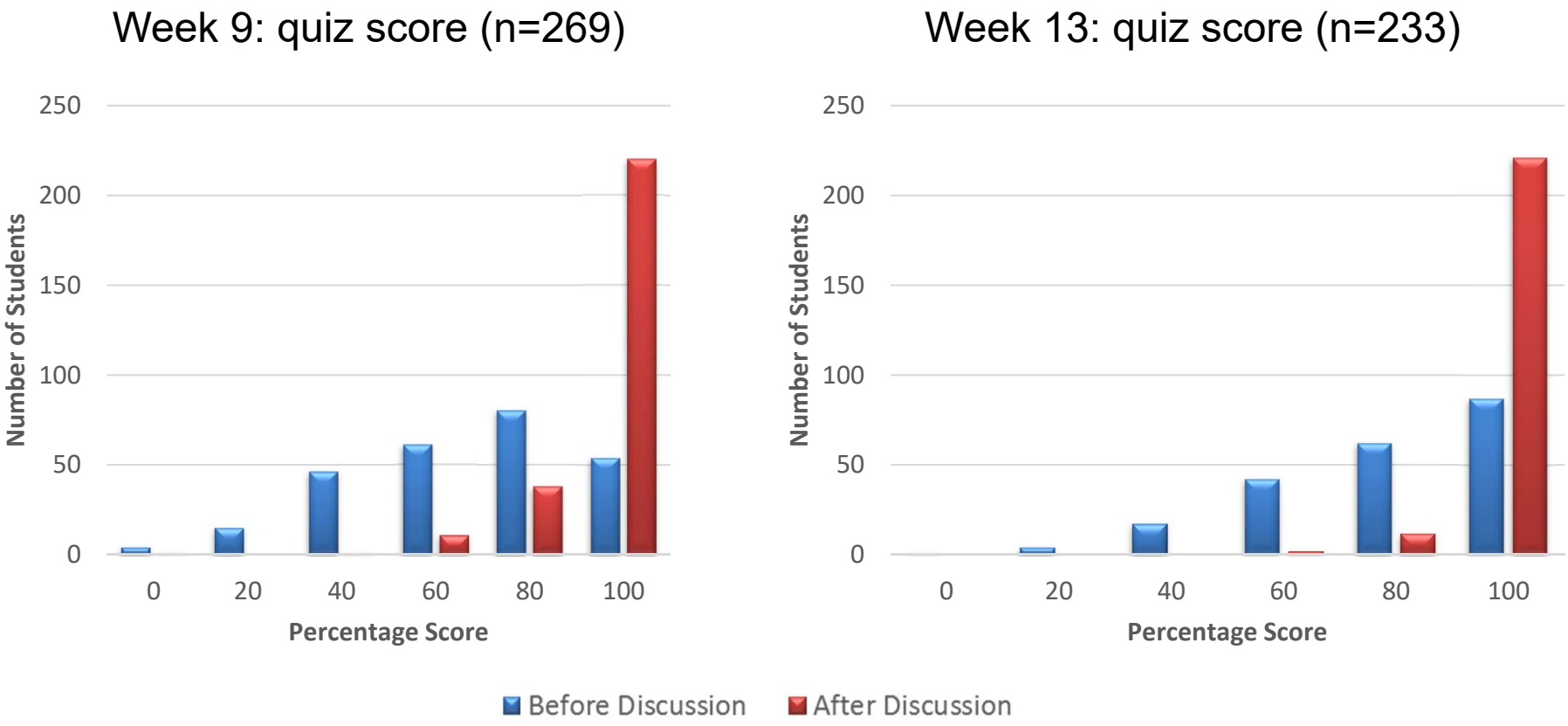
Sometimes the flipped classroom ***contents*** gets too heavy (on the cell signals, especially on particular process), and its hard to adsorb since it is only briefly covered and good depth knowledge is needed.

I really like it but I am afraid of forgetting to do it.

Please give me detail and perhaps, ***transcript*** of the lecture as well. Some word is really hard to hear and some points are not well elaborated

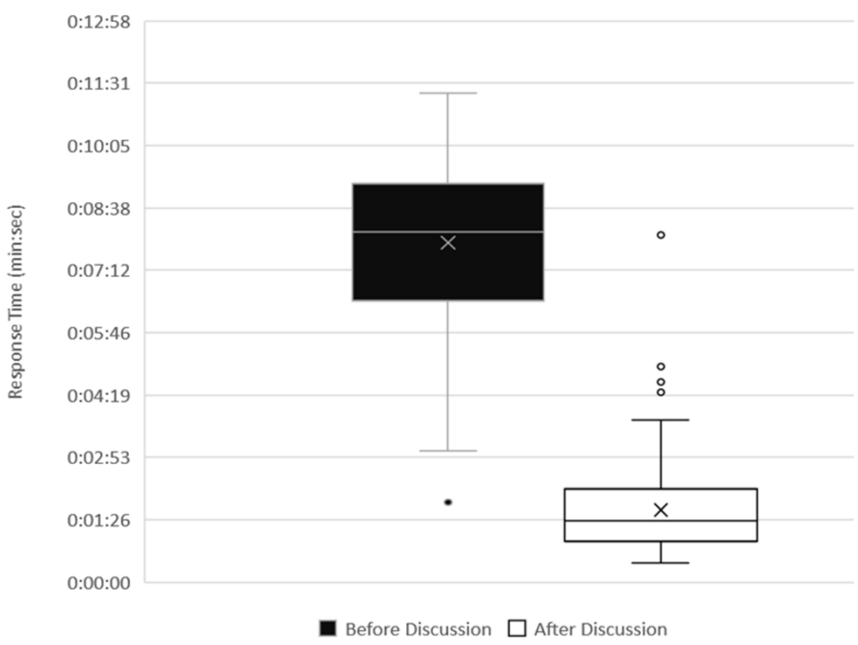
Results-II: Students' Performance

In-class Quiz Score (before v.s. after discussion)

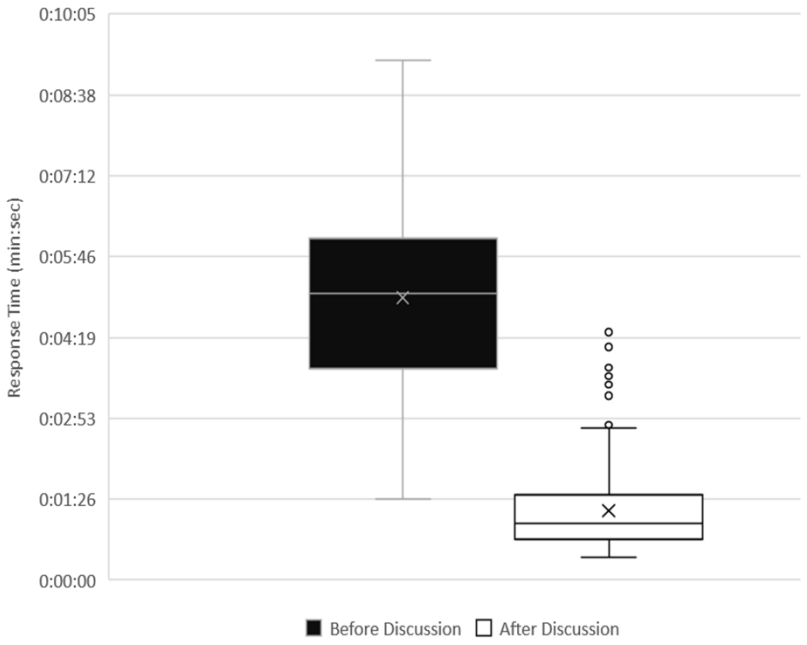


In-class Quiz Response Time (before v.s. after discussion)

Week 9: response time (n=269)

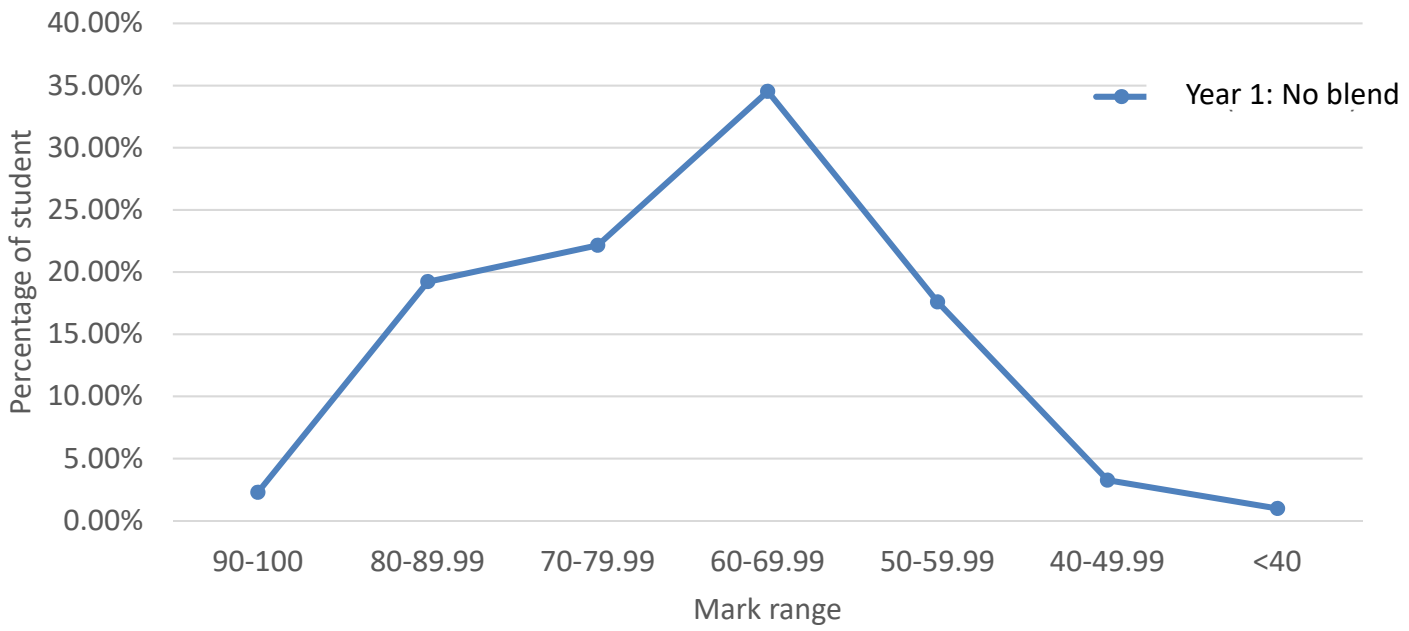


Week 13: response time (n=233)

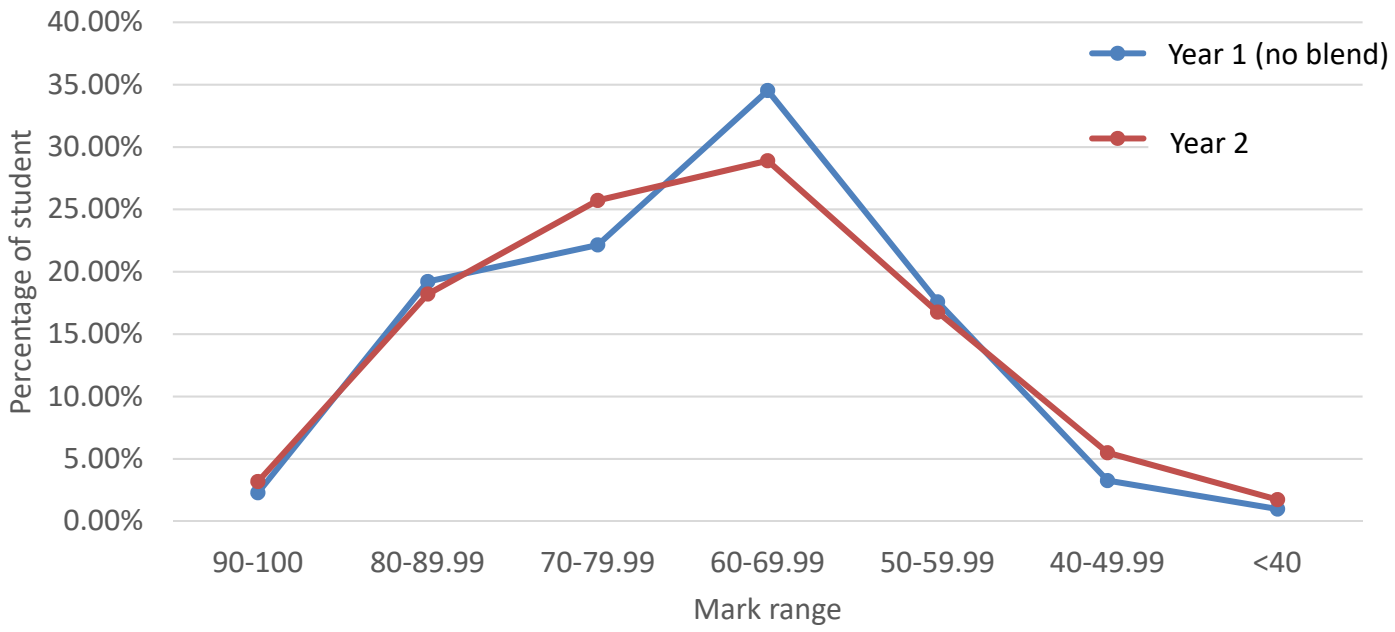


Note: Results are presented as mean +/- STD, p <0.001.

Students Performance in Final Exam



Students Performance in Final Exam



Conclusion

Key Findings

- Majority of students find the course to be well organized and structured.
- Student gains are promising and they were actively involved in learning experiences.
- Blended learning changes instructors' roles and may help attract, retain, and leverage the best.

More details about this research: "An investigation into the impact of flipped classroom with active learning on the perception and performance of biology non-major students at the undergraduate level." **Journal of College Science Teaching** (coming soon)

Acknowledgments

1. “The Introduction to Biology” Team of Instructors from SUTD (photo on the right)

2. Chan Jun Wei from SUTD

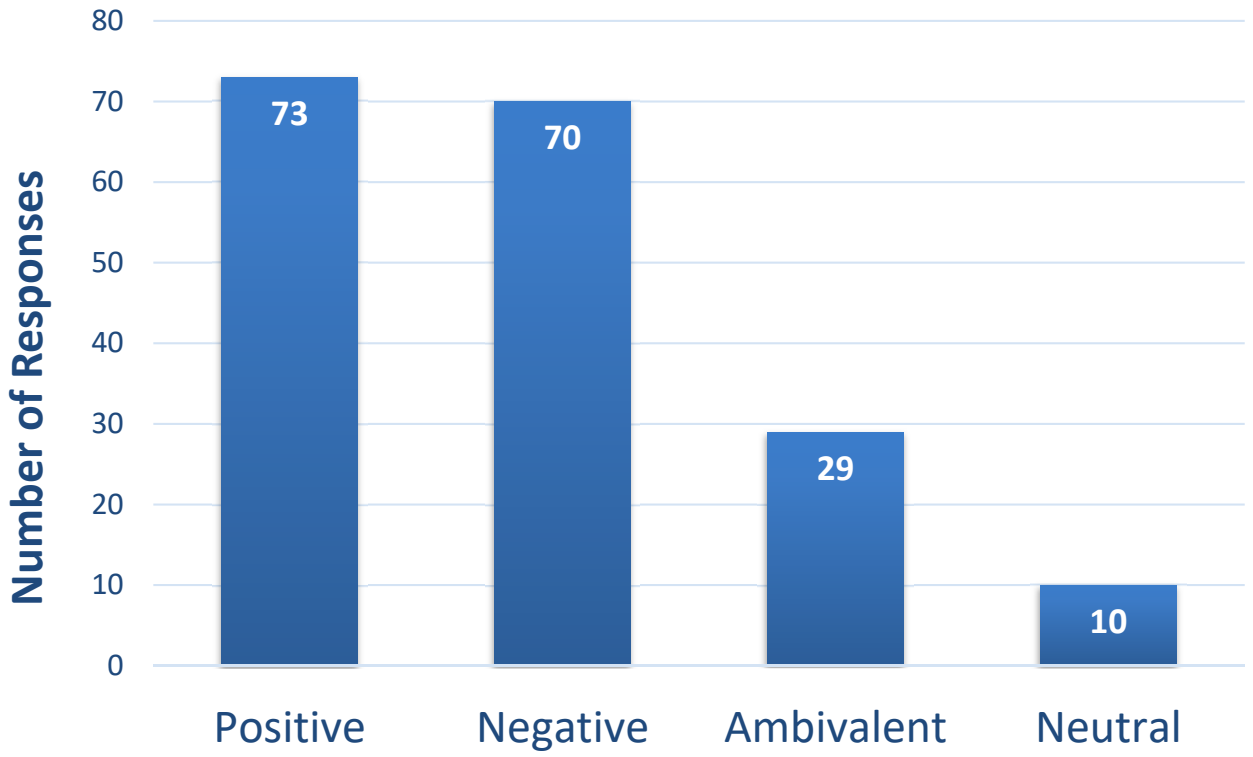
3. Funding support from the SUTD Pedagogy Innovation Grant, 2015-3019.

Second role: Bina Rai, Dawn C-I Koh, Lakshminarasimhan Krishnaswamy
Front row: Leo Chen Huei, Khoo Xiaojuan, Julia Yajuan Zhu, Rajesh Chandramohanadas
Note in this photo: Ong Eng Shi

Thank You

A BETTER WORLD BY DESIGN.

Specific Feedback _ Open Ended Question



Students Performance in Final Exam