Student-centric techniques in f2f classrooms, flipped classrooms and MOOCs: improving learning and engagement

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IDP in Educational Technology
Indian Institute of Technology Bombay

Engineering Conclave 2016, IIT Madras
September 1, 2016

Inter-Disciplinary Program in Educational Technology (est. 2010)

Focus –

Technology tools for teaching-learning (ex – intelligent tutoring systems)

Pedagogical processes for effective teaching-learning from above

Research - Ph.D. program (~25 research scholars), focus on:

- *TELoTS (12 PhD students)*: Technology enhanced learning environments for developing students' pan-domain thinking skills.
- *TUET (4 PhD students)*: Teacher use of educational technologies and strategies.

Outreach, training, CEP

- ET4ET, 4000+ participants under NMEICT project Train 10000 Teachers. Jan-Feb 2015.
- MOOC on IITBx – ET601Tx, 5500 participants. Jan-Mar 2016.

Today's talk

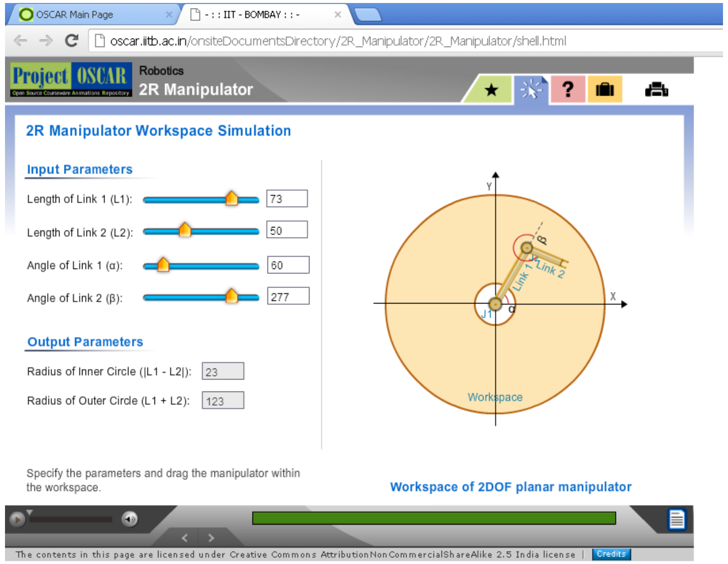
Today's talk is about some research, development and outreach work from Project TUET (Teacher Use of Educational Technology), with examples from f2f classrooms, flipped classrooms, MOOCs.

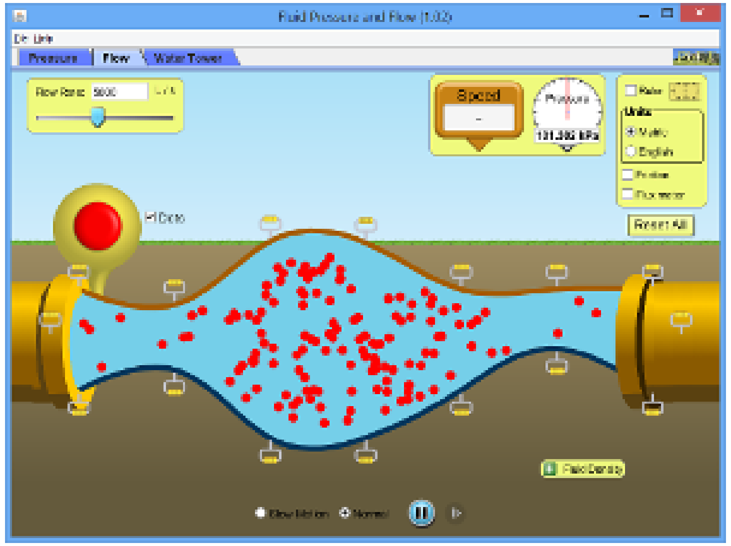
Work done with IDP-ET PhD students, IITB engg dept faculty, University engg faculty

Today's talk is also about examining some assumptions on teaching, learning based on research – theory and evidence.

Scenario 1: Using visualizations in class

Visualizations such as animations and simulations have been shown to provide many learning benefits, especially in STEM disciplines.





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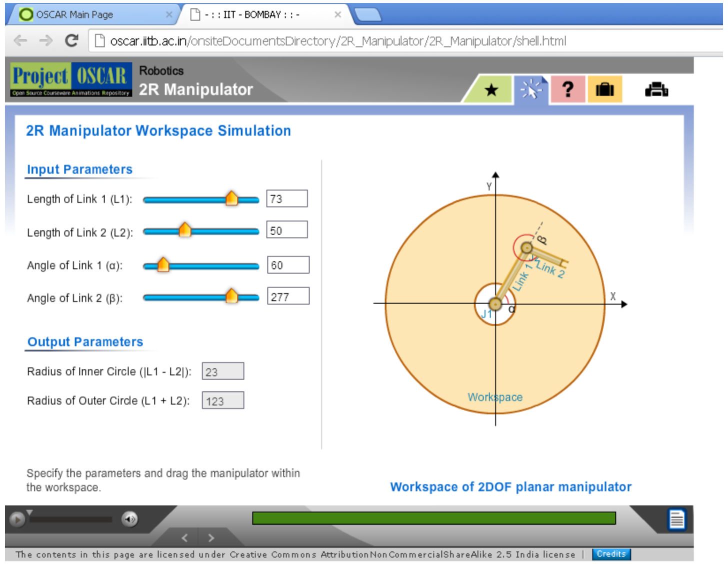

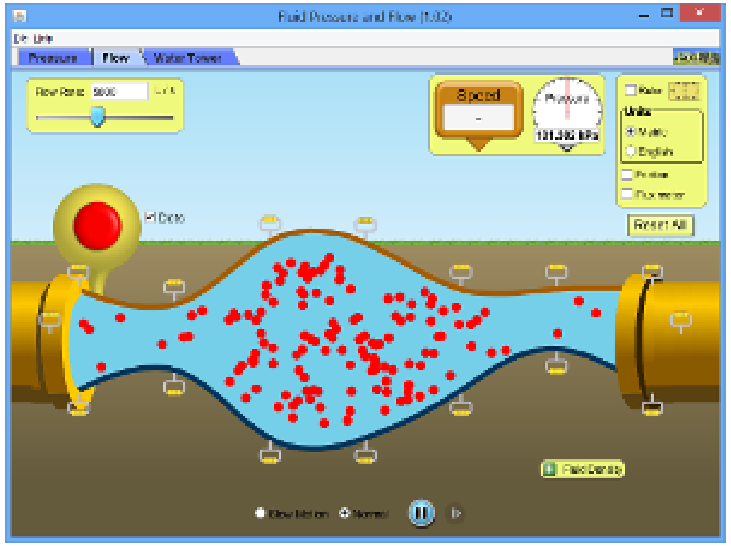

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Many teachers report using such visualizations in their class. Most play or demonstrate the animation in class, along with narrative explanation.

VOTE - Do you think demo & explanations of visualization is effective?

1) Yes
2) No

Results from research on use of visualizations

- Showing demo alone is not effective (Hansen et al 2000)
- Potential benefits of visualization is lost if students merely watch (Lindgren & Schwartz)
- The way the instructor teaches with the visualization has a profound effect on learning effectiveness (Bratina et.al, 2002).

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- The way the instructor teaches with the visualization has a profound effect on learning effectiveness (Bratina et.al, 2002).

- Active-learning instructional strategy with visualization led to improved outcomes than mere viewing (Laasko et al 2009; Windschitl & Andre 1998, Banerjee, Murthy & Iyer 2015)

What is active learning?

- Students go beyond listening, writing notes, executing prescribed procedures.
- Students asked to ‘figure things out’ *during class.*
- Students work on carefully designed activities that require them to talk, write, draw, solve, collaborate, reflect and express their thinking.

- Examples – Peer Instruction, Think-Pair-Share, PBL, Peer-review, Role play …

Example of short active learning strategy– Predict outcome

Observe Phase

TEACHER:
- Play viz upto the point the stimulus is shown.
- PAUSE before result. Don't show rest of viz yet.

STUDENTS:
Observe first part of viz

→

Predict Phase

TEACHER:
- Ask students to make prediction: "What will happen if …"

STUDENTS:
- Make prediction – write or vote, discuss w each other

→

Check Phase

TEACHER:
- Shows rest of viz, which has result

STUDENTS:
- Check their prediction by watching the result in viz

Will the balloon move?

A) Yes, to the left

B) Yes, to the right

C) No

Show rest of movie

http://paer.rutgers.edu/pt3/experiment.php?topicid=13&exptid=121

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- Examples – Peer Instruction, Think-Pair-Share, PBL, Peer-review, Role play …

- Explicitly based on theories of learning.
- Evaluated repeatedly through empirical research.

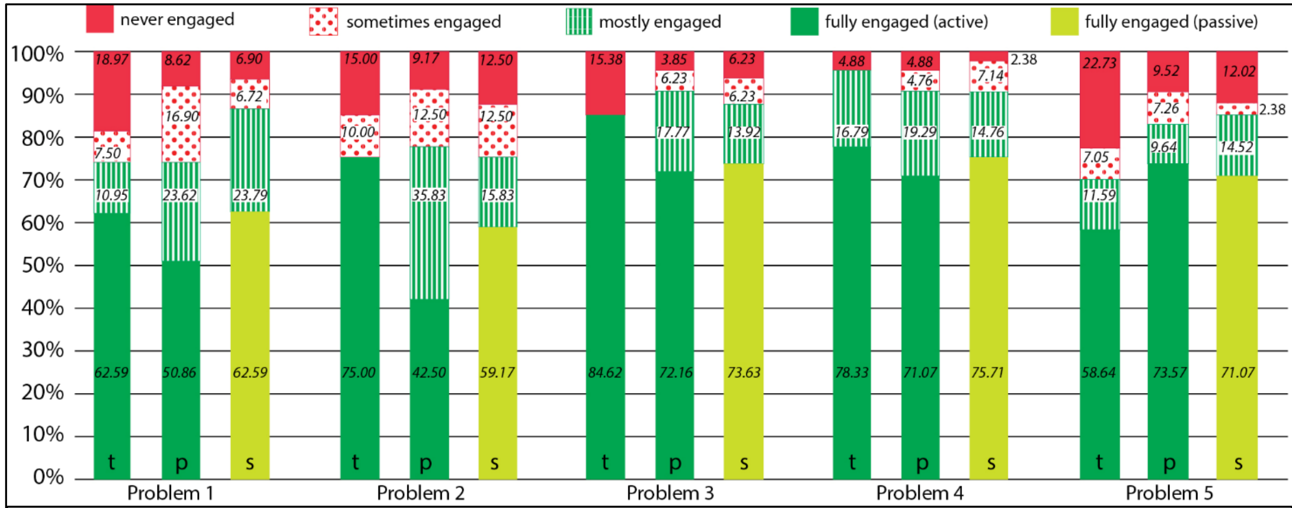
- Not merely an interactive lecture (did you understand? clear doubts, Q&A)

Our research: Think-Pair-Share in CS101 improved student learning and engagement

Observation Protocol

observation protocol

codes	students / observations	1: 1	1: 2	1: 3	2: 1	2: 2	2: 3	3: 1	3: 2	…	n: 1	n: 2	n: 3
W	Writing in notebook.			x	x						x		
RN	Reading own or neighbours notes.											x	
RS	Reading the screen.	x						x					x
T	Talking to peer on topic.		x						x	x			
L	Listening to peer on topic												
IQ	Ask question about the problem posed												
IP	Group discussion, more than two people.												
IR	Respond to teacher question.												
LN	Looking at own or neighbours laptop.												
OS	Out of seat.												
MO	Playing with mobile, tablet, pen etc.												
F	Fidgeting in seat.												
LA	Looking around room.					x	x						
SA	Staring away.												
HD	Head down/ sleeping.												
TF	Talking off topic with peers												
LD	Looking down; doing other work.												



Overall engagement (N=228) = 83% average

Experimental group Mean (N-250)	Control group Mean (N=169)	p
1.91 (1.65)	0.88 (1.3)	0.001**

Learning – problem solving test, 2 groups

Scores of TPS group higher than control group

A. Kothiyal, R. Majumdar, S. Murthy and S. Iyer, "Effect of Think-Pair-Share in a large CS1 class: 83% sustained engagement" ACM – ICER, San Diego, 2013

Active Learning in IITB courses: Research studies

	COURSE	ACTIVE LEARNING STRATEGY	RESULT
CS101	Computer programming 2013 & -14 (N=450, each)	**Think-Pair-Share, Peer Instruction** *A. Kothiyal, R Majumdar, SM and S Iyer. "Effect of Think-Pair-Share in a large CS1 class: 83% sustained engagement" ACM International Computing Education Research, San Diego, 2013*	83% students engaged (observation protocol) Higher learning than lecture (controlled expt) High student perception (survey, course eval)
EE 590	Foundations of projects 2014	**GPGP – Guided Problem-solving and Group Programming** *A Anand, A Kothiyal, B Rajendran and SM. Guided Problem Solving and Group Programming: A Technology-Enhanced Teaching-Learning Strategy for Engineering Problem Solving. IEEE International Conference T4E 2014, Kollam.*	Significant pre-post gain on problem-solving skills; High perception of learning
EE 746	Neuromorphic engg 2013	**Delayed Guidance – in-class ill-structured problem solving** *A Kothiyal, B Rajendran and SM. Delayed Guidance: A teaching-learning strategy to develop ill-structured problem solving skills in engineering. LaTiCE 2015, Taipei*	Higher problem solving skills compared to traditional methods (controlled expt); Wider range of problem solving heuristics
CS 213	Data structures and algos. 2014	**Think-Pair-Share** *D Reddy, S Mishra, G Ramakrishnan and SM. Thinking, Pairing, and Sharing to improve learning and engagement in a Data Structures and Algorithms (DSA) class. LaTiCE 2015, Taipei*	Relative gain twice for TPS topic than traditionally taught topic Majority students wanted more TPS topics
CS 716	Computer networks 2009, -10, -11	**Analogical problem solving, TPS, PI** *S Iyer and SM. "Demystifying networking: teaching non-majors via analogical problem-solving". ACM Symposium on Computer Science Education (SIGCSE 2013), Denver, USA, March 2013.*	Students able to apply concepts from real life to solve networking problems in new unseen topic

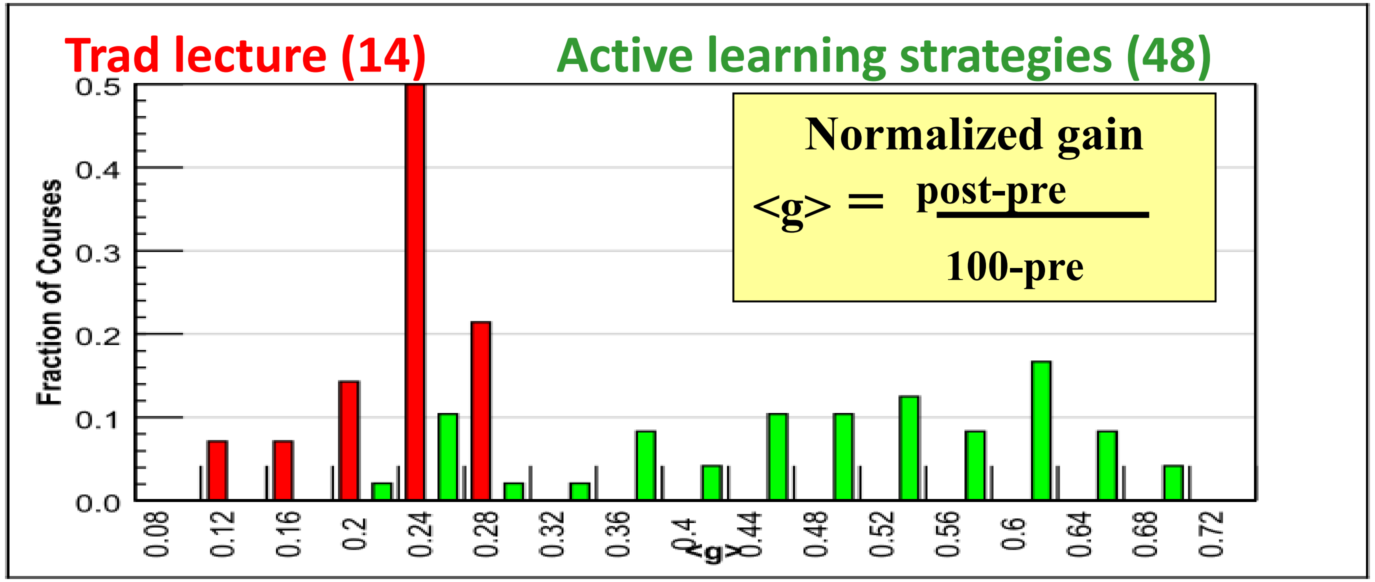
Results from literature in support of active learning

Comparative study, 62 courses

- High school, college, university
- 6542 students
- Test of conceptual reasoning – Force Concept Inventory

AL courses had semester long pre-post gains 2-3 times greater

R. Hake, Am. J. Phys., **66** (1998)



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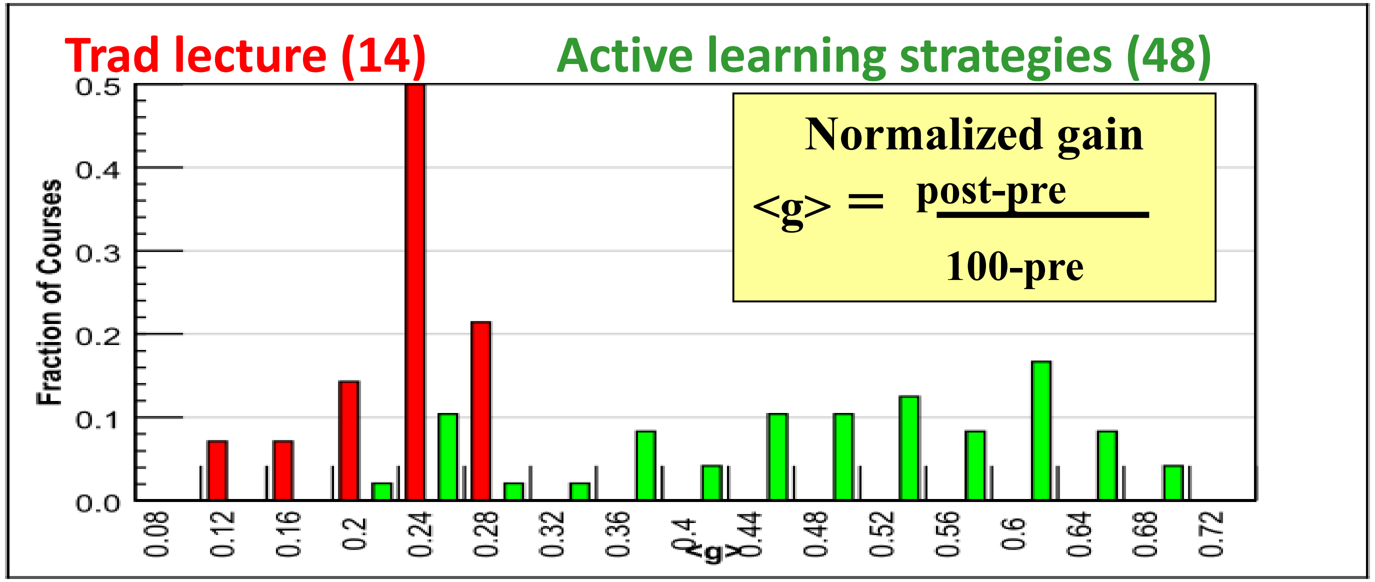

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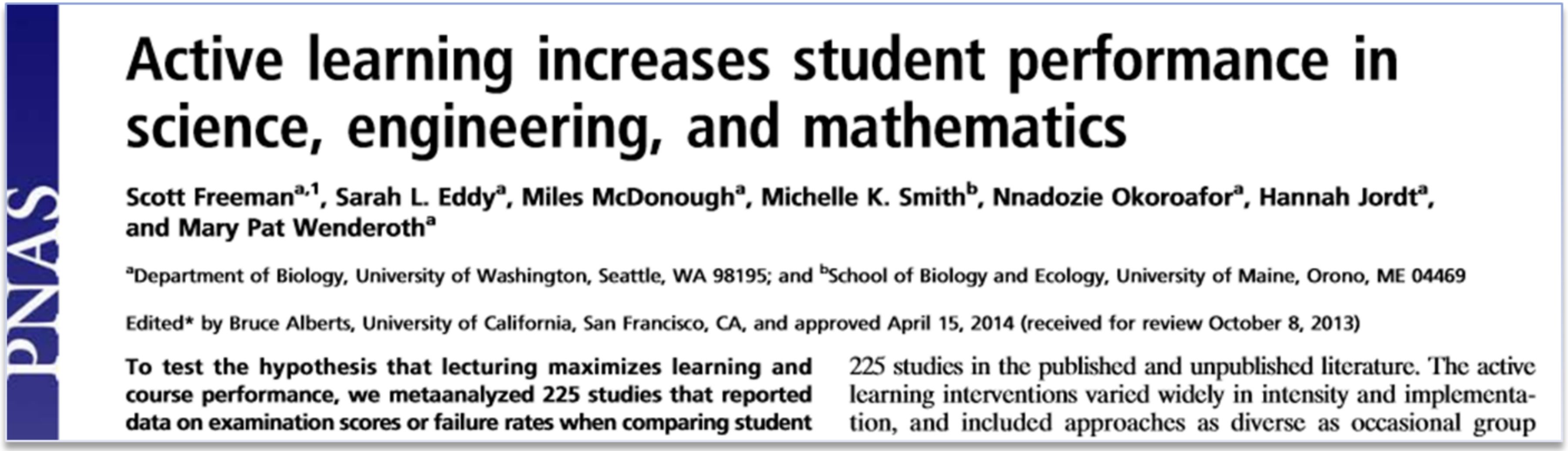

PNAS

Active learning increases student performance in science, engineering, and mathematics

Scott Freeman[a,1], Sarah L. Eddy[a], Miles McDonough[a], Michelle K. Smith[b], Nnadozie Okoroafor[a], Hannah Jordt[a], and Mary Pat Wenderoth[a]

[a]Department of Biology, University of Washington, Seattle, WA 98195; and [b]School of Biology and Ecology, University of Maine, Orono, ME 04469

Edited* by Bruce Alberts, University of California, San Francisco, CA, and approved April 15, 2014 (received for review October 8, 2013)

To test the hypothesis that lecturing maximizes learning and course performance, we metaanalyzed 225 studies that reported data on examination scores or failure rates when comparing student 225 studies in the published and unpublished literature. The active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group

Meta-analysis, 225 studies

- Exam performance: higher by 0.47 SD ~ 1/2 letter grade increase
- Failure rates 2/3

Proc. Natl. Acad. Sc, 111(23), 2014

Takeaway

Make students grapple with content *during class.*

Don’t only clarify doubts, use proven methods like active learning strategies.

Scenario 2: Videos for a flipped classroom

EXPERIMENT: Two videos of same instructor, same content.

STUDENTS: Split into two groups, equivalent achievement level.

GROUP 1 – 'Fluent' video. Instructor speaks fluently, no notes, upright, maintains eye-contact

GROUP 2 – 'Disfluent video'. Instructor speaks haltingly, often refers to notes, slouches, poor body language

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VOTE – Which group do you think performed better on the post-test?

1) Group 1
2) Group 2
3) Both did same

Results of fluent vs disfluent videos

EXPERIMENT: Two videos of same instructor, same content.

STUDENTS: Split into two groups, equivalent achievement level.

GROUP 1 – ‘Fluent’ video. Speaks fluently, no notes, upright, eye-contact, …

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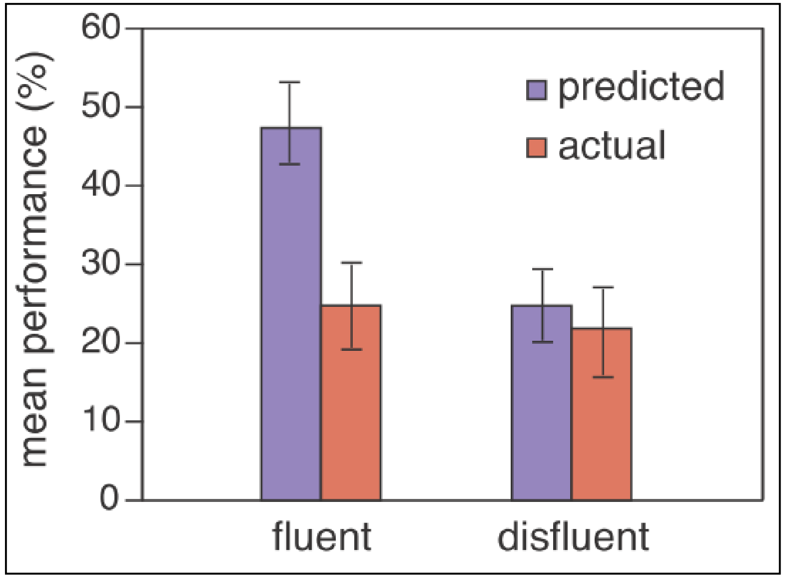
doi: 10.3758/s13423-013-0442-z



RESULTS

1) Fluent video: Perceived learning greater than actual learning

2) Disfluent video: Perceived learning equal to actual learning

3) Both groups: *Same actual learning!*

Implication: Improving fluency of lectures does not imply better learning.

What exactly happens during “flipping”?

TRADITIONAL CLASS

Information Transmission → In class (f2f)

Assimilation → Outside class (tech)

FLIPPED CLASS

Information Transmission → Outside class (tech)

Assimilation → In class (f2f)

Flipped class is not about reducing teacher’s time or effort.

What leads to better learning and engagement?

- Outside-class activities (short videos, screencasts) should:
  - Address learning of facts, knowledge, basic concepts at recall and understand level
  - Be interactive – include short assessment Qs in between videos
  - Provide formative feedback

- f2f class activities should:
  - Address higher order learning - application, analyse, planning and producing solutions
  - Include individual and collaborative active-learning strategies that contextualise and apply knowledge

- Coherently link to outside class and f2f parts

Our research on flipped and blended modes

- Context – NMEICT Train 10000 Teachers workshop Jan 2015

  Effective pedagogical strategies for ICT integration for engg teachers

- Used flipped approach for topics Visualization, Screencasting, Wikis

- Perception of technology competence - High (median 3/4, N = 1700)

- Pre-post significant differences in learning – lesson plans of 554 participants

Warriem, Murthy, Iyer, 2014, 2015

Results from literature in support of flipped class

Meta-review of 28 studies, 5 countries. (Flaherty & Phillips, 2015)

Method: compare existing traditional class with embedding flipped class

Results:

- Largely - Increased student satisfaction but some less satisfied
- Increased perceived engagement, particularly with interactive videos, f2f AL
- Modest improvement of academic performance, mostly short term

Verdict:

- Limited evidence on learning outcomes, especially in higher-ed
- Need more studies, particularly longitudinal

Takeaway

Flip to a higher order.

a. Don’t only create videos for outside class, do recall / understand self-assessment

b. Don’t only answer doubts in class, do active-learning for application and problem-solving

Scenario 3: Teaching and assessment in a MOOC

Massive Open Online Courses – LARGE numbers (few 1000), ex - edX

Assessment is a challenge ==>

Largely resort to automatically graded multiple-choice ques, short answers.

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Increasing instances of complex assignments (eg design) with <u>peer assessment</u>.

VOTE - Do you think peer assessment is effective?

1) Yes
2) No

Research and theory on peer-assessment

- Formative assessment techniques such as peer-assessment and self-assessment give most ‘bang for the buck’ (Black & Wiliam, 1998)

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Where are you now?

Help student realize current level of understanding

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Where are you trying to go?

Identify learning goals

Where are you now?

Help student realize current level of understanding

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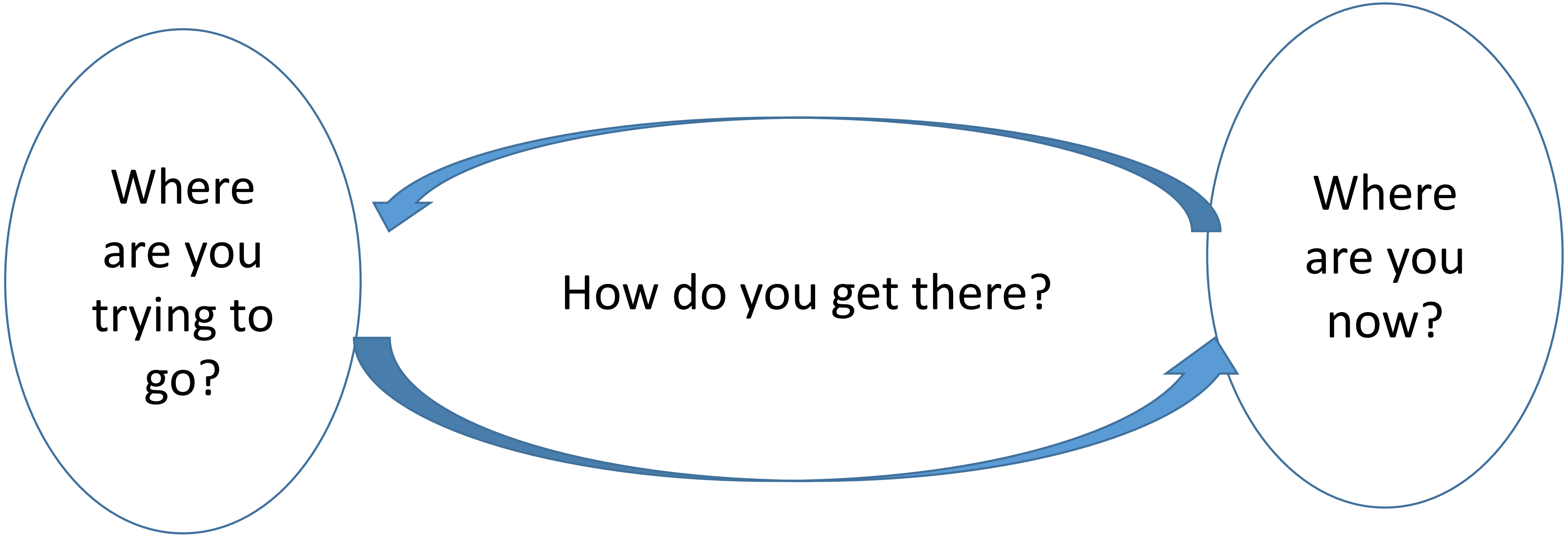

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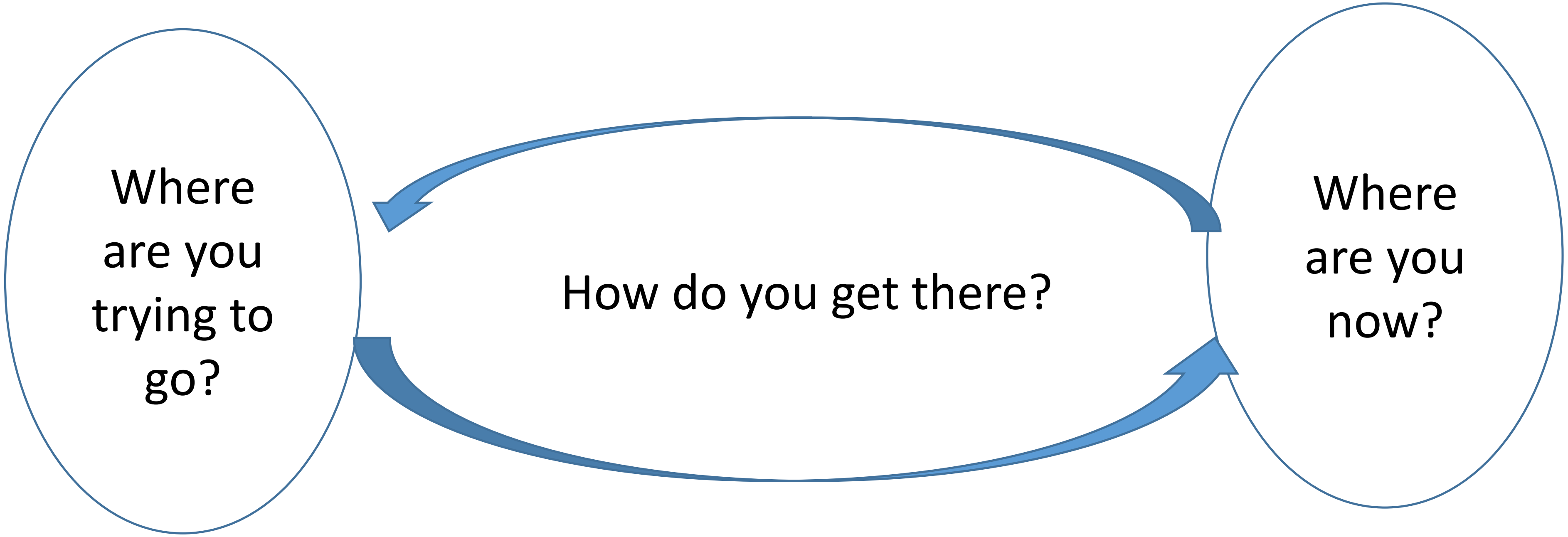

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How to implement formative assessment - Rubrics

Dimension	Target	Needs improvement	Inadequate	Missing
Is able to design a student-centric instructional strategy aligned to learning objectives	Instructional strategy is aligned to level of learning objective. Strategy gets student to do active learning. Student activities clearly described.	Instructional strategy is aligned to level of learning objective. Student activities not clearly described. Largely information transmission.	Instructional strategy not aligned to level of learning objective.	No attempt is made

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PEER ASSESSMENT DONE WELL

Focuses not so much on grading but on the give-and-take of feedback

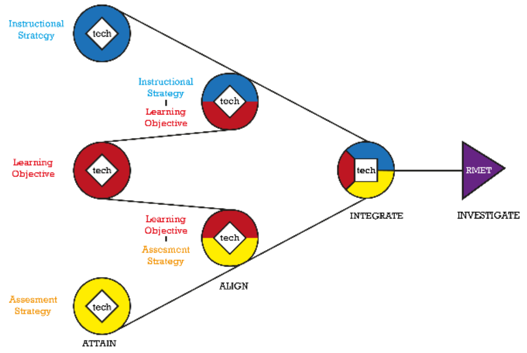
Engages students in higher order thinking – judgment, evaluation

Promote learning of both assessor and assesse

Timely, frequent, detailed

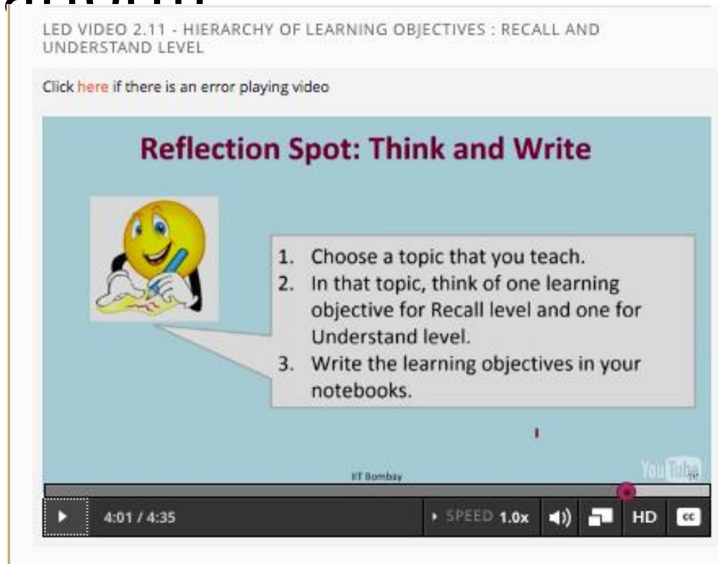
Our research on MOOCs – Theory

- Developed Align-Attain-Integrate-Investigate model



- Identified key design drivers
  - Immersivity, Pertinancy, Transfer of ownership

- Included strong pedagogy to exploit potential of MOOC platform
  - Learning Dialog videos with Reflection Spots
  - Learning by Doing activities with (auto) reflective self-assessment
  - Practice-focused Discussion Forum with Reflection Quiz



(thesis of Jayakrishnan Warriem, ET, IIT Bombay)

Warriem, Murthy, Iyer, 2014, 2015

Our research on MOOCs – Practice

- Conducted ET601Tx on IITBx – Educational Technology for Engineering Teachers
  - Jan-Mar 2016, 5500 participants

- Designed based on A2I2 model and design drivers

Warriem, Murthy, Iyer, 2014, 2015

Our research on MOOCs - Results

Participation rates

- 67.4% Active Participants and 36.58% persistence rates
- 5023 Threads started and 9861 comments by participants
- 400 participants average daily access

Perceptions (survey questionnaire):

- High relevance and usefulness for LeD Videos, LbD Activities and Discussion Forums

- Learning performance results being analysed

Takeaway

Have explicit reflection activities.

Don’t just put up videos & assignments, empower formative assessment.

Why do these techniques work?

What do students do?

- Talk, argue, listen (sometimes), reason, draw
- Work through hard and messy content, make decisions
- Learn from each other, teach each other
- Explicitly reflect on what they learnt

What does instructor do?

- Learning coach
- Provide sufficient structure and guidance (but not directives)

Student-centric

Takeaway Mantras - Summary

In f2f class:

Make students grapple with content *during class.*

Don’t only clarify doubts, use proven methods like active learning strategies.

In flipped classroom:

Flip to a higher order.

a. Don’t only create videos for outside class, do recall / understand self-assessment.

b. Don’t only answer doubts in class, do active-learning for application and problem-solving.

In MOOC:

Have explicit reflection activities.

Don’t just put up videos & assignments, empower formative assessment.

Final thoughts

Our goal as teachers: Students are engaged (with content), they learn.

We are all striving towards improving above. But -

Some techniques are known to work, others are known to *not* work.

So –

Become informed of research on teaching & learning

Small tweaks may lead to improvement if they are the right tweaks

Thank you!

www.et.iitb.ac.in

Resources for instructors – Videos & slides on techniques,

Examples in many domains, Activity Constructors

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