Active Learning: Why, What & How

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Warm up

Think of one activity that you feel you excel at doing

Write down your answer. You need not share this with anyone!

Think about why you are so good at this activity

Write down the top 3 reasons for your mastery in this activity

Let me guess - One of your top 3 reasons is likely to be:

– Practice. "Experience"

Practice

Again, think of the activity that you feel you excel at doing

Do you feel that you could have gained such mastery by listening to lectures on the topic?

Point to keep in mind:
As learners, we develop mastery through practice (doing activities, rather than simply listening to lectures, or watching demos)

So,
As teachers, we must ensure that we provide our students with practice – sufficient and timely opportunities

Think of a ‘good’ teacher that you had

What did this teacher do, that made you feel he/she was ‘good’?

Each one say one

Note audience responses on next slide

Audience - ‘Good’ teacher characteristics

- Passionate about subject
- Knowledgeable
- Good Communication
- Philosophical way of teaching – motivational
- Makes lecture interesting ‘competitions, rewards’
- Practical examples
- Accessible to clears doubts, helpful after class
- Evaluation
- Topical jokes
- Friendly and open to criticism
- Real-life examples, analogies
- Pertinent to exams and jobs
- Extra classes if required
- Punctual

- Compassionate towards students
- Gave practice
- Opportunity for each student
- Encourages student participation, confidence
- Provide hint, not solution
- Encouraged to try things beyond syllabus
- Encouraged projects

20th Century Teacher

Teacher A gives an excellent lecture in the class, demonstrates solving many problems, and gives appropriate homework to her students

In the 20th century, information was at a premium – No Internet, expensive books, limited access to libraries, and so on
Hence, those who had access the information and could transmit it effectively were highly valued

So, students were mostly passive listeners, absorbing information during the lecture, and doing their practice later

What has changed in the 21st century?

21st Century Teacher

Think: What has changed in the 21st century that affects teaching? Write one point in your notebook

Pair: Discuss the changes with your neighbor. Together, come up with one way you can adapt to the changes, as a 21st century teacher

Share: Discuss with entire class

Note audience responses on next slide

Audience – 21st century teacher

What has changed from 20th century?

- Smart class available
- Online tutorials, channels
- MOOCs
- Digital libraries, ebooks
- Virtual labs
- Research facilities, interdisciplinary branches
- Application focus by students
- Teaching like a business
- Collaboration opportunities, increased interaction
- Web
- Multiple intelligence ?
- Teacher-student ratio decreases

How do we adapt?

- "Better" presentations
- Solving real-life problems
- Research oriented teaching
- Ask student's preferences
- Getting familiar with technology
- Give more direct applications
- Industry visit, short courses
- Group work

21st Century Teacher

In the 21st century, information is no longer at a premium – lot of accessible videos, demos, and so on

Hence, it is not enough for a teacher to only transmit information effectively

It is necessary for a teacher to ensure that her students are able to assimilate the information, through appropriate practice, during the lecture itself

Shift of focus from Teacher-Centric to Student-Centric pedagogy

21st century teaching

- Consider a large class. Ex: CS1 to 450 first year undergraduate students, across various engineering disciplines

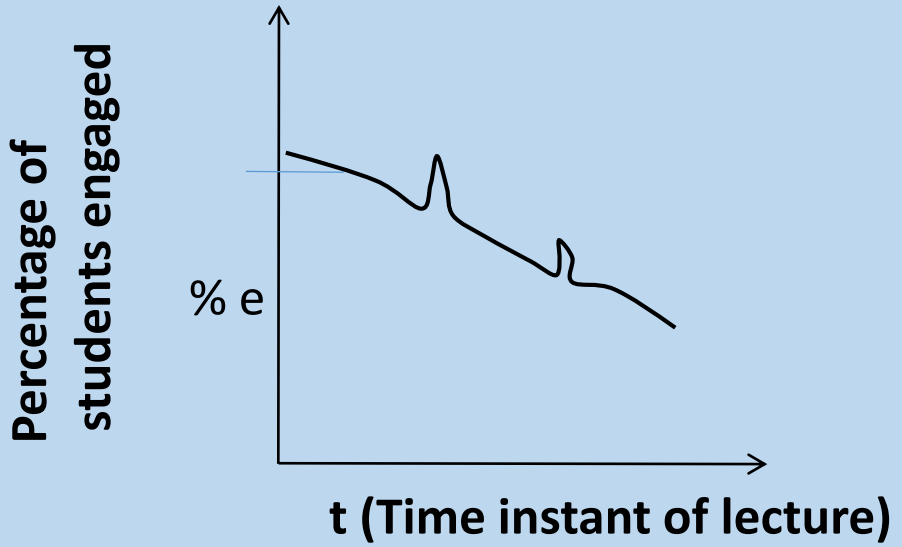
- Imagine a 90-minute class in 20th century lecture mode, in a large auditorium with fixed seats (Oh yes, we still have many of those)

- Do activity on next slide

Think-Pair-Share Activity

Think (Individually):

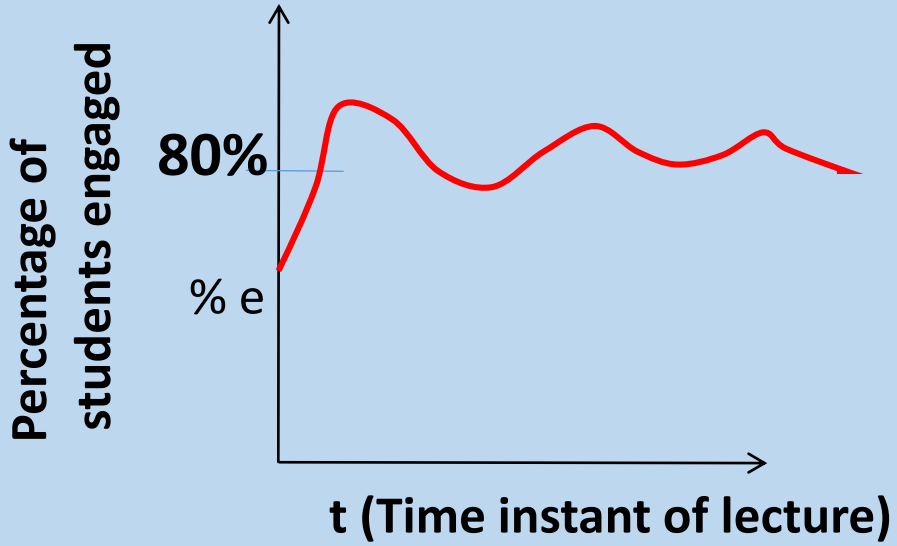
- Predict the percentage of students who may be showing “engaged” behaviour (with the content of the lecture), at various instants of time
- Draw a graph of engagement versus time [~1 min]



Think-Pair-Share Activity

Pair (with your neighbour):

- Examine each other's graphs [~1 min]
- Together, come up with two techniques that could be used to convert your graph into something that looks like the figure shown [~2 min]



Share (entire audience):

- Share pros and cons of some techniques

Audience – Techniques for engagement

- Have small activities, Interactive
- Ask for examples
- Some demonstrations
- Video + slides + Animation
- Telling Jokes
- Ask them to stand up and clap
- Allow students to move around
- Giving small breaks
- Play games
- Ask personal interest

- Keep blue slides in the ppt
- Discuss previous class hw
- Group activities – call on stage to make diagrams, present topic
- Make partner for discussion
- Include puzzles in slides
- Include quizzes, at end and in-between
- Rewards and perks for asking Qs

How to do learner-centric pedagogy

One way – Active learning techniques

- Students go beyond listening, writing notes, executing prescribed procedures.
- Students asked to ‘figure things out’ *during class*

Needs attitude shift of teacher:

- from content-oriented to learning-oriented
- from “How well am I lecturing?” to “How well are they learning?”

So, what are active learning strategies?

Requirements:

- Students go beyond listening, copying of notes, execution of prescribed procedures
- Instructor designs activities that require students to talk, write, reflect and express their thinking

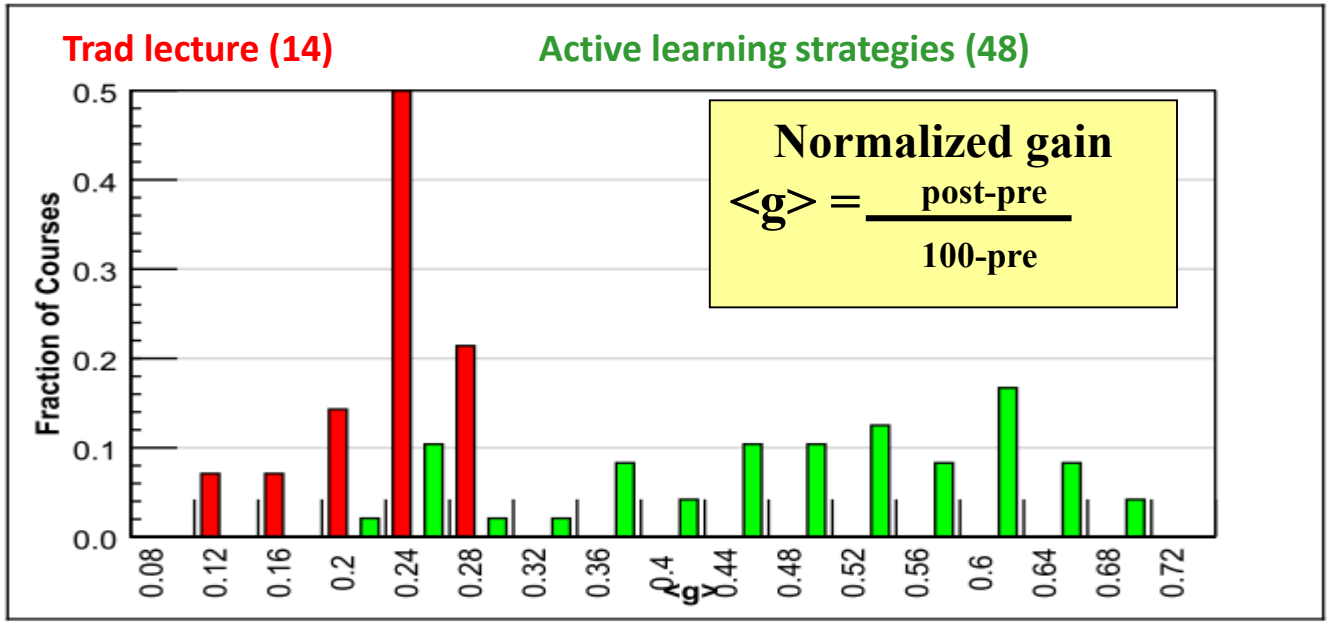
- Explicitly based on theories of learning
- Evaluated repeatedly through empirical research

D. E. Meltzer and R. K. Thornton. "Resource letter ALIP–1: active-learning instruction in physics." *Am. J. Phys,* 80.6 (2012): 478-496

Evidence from research

Comparative study of 62 Physics courses (1998)

- 6542 students
- Variety of institutions: high school, college, university
- Semester long physics course
- Pre-post test of conceptual reasoning – Force Concept Inventory



IMPLICATION

Desirable to explicitly incorporate learner-centric activities in our teaching.

RESULTS:

- Maximum gain from lecture courses was 0.28
  - Many instructors had high teaching evaluation scores
- Gain from learner-centric courses had gains 0.23-0.7, which was 2-3 times greater than lectures

R. Hake, "Interactive-engagement versus traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses" Am. J. Phys., **66** (1998)

Many teachers say - My lectures are plenty interactive!

- *I often pause to ask students if they understood the material*
- *I allow students to interrupt whenever they have doubts*
- *I never hesitate to answer their questions*
- *I show them demos and videos*

….

Isn’t this active learning?

Why ‘interactive lectures’ may not be enough

- Students don’t pay utmost attention throughout the lecture
- Students *think* that they understand because they can follow the lecture
  - They are not confronted with their misconceptions immediately

- Difficult to ensure that all students in the class participate actively
  - Students with high motivation / achievement levels drive the pace
  - Students with low achievement levels get left behind

- Students may have a barrier to responding directly to the instructor
  - Shy students don’t ask questions, or give answer, even if they have one
  - Forcing all students to respond tends to be counter-productive

Features of active learning

- Students engage in problem-solving activities *during* class time

- Specific student ideas are elicited and addressed
- Students are asked to “figure things out for themselves”
- Students are asked to express their reasoning explicitly
- Students work collaboratively

- Students receive rapid feedback on their work
- Qualitative reasoning and conceptual thinking are emphasized

What are some active learning strategies

- Think-Pair-Share [Frank Lyman, University of Maryland, early 1980s]
- Peer-Instruction [Eric Mazur, Harvard University, early 1990s]
- Team-Pair-Solo [Spencer Kagan, University of California, early 2000s]
- Many others:
  - Debates, Role-play, Jigsaw, problem-based learning, productive failure.

Think-Pair-Share (TPS)

- What is TPS? - Illustrated through activities on earlier slides
  - Definition follows on the next slide

- Why use TPS?
  - Well known challenges to teaching-learning in large classes – more easy for students to tune out and get distracted into using their mobiles, talking, or other off-task activities
  - Active learning techniques that engage the entire class are required
  - TPS is a relatively easy way to achieve the benefits of small group cooperative learning in a large class
  - Formative assessment (rapid feedback that can be acted upon) is possible

TPS: Definition

Collaborative, active learning strategy, in which students work on a problem posed by instructor,

first individually (Think), then in pairs (Pair) or groups, and
finally together with the entire class (Share)

•**T** (Think): Teacher asks a specific question about the topic. Students "think" about what they know or have learned, and come up with their own individual answer to the question. [Takes 1-3 Minutes].

•**P** (Pair): Teacher asks another question, related to the previous one, that is suitable to deepen the students' understanding of the topic. Each student is paired with another student. They share their thinking with each other and proceed with the task. [Takes 5-10 Minutes].

•**S** (Share): Students share their thinking (or solution) with the entire class. Teacher moderates the discussion and highlights important points. [Takes 10-20 minutes].

TPS: Benefits

- Why does TPS work?
  - Students are actively engaged
  - Students learn from each other (social process, teach=>learn)
  - Students can tackle large and ill-structured problems, and develop the ability to consider multiple points of views

- Other benefits:
  - Makes class interactive
  - Students realize that even others are struggling
  - Builds a friendly, yet academic atmosphere
  - Includes all the students in the teaching-learning process

TPS in CS 101: Example 1 (conceptual)

- "Consider an unsorted array of N elements".
- Think: Write the pseudo code for sorting the array.
  - *Students do: Write down answer the given question.*
  - *Instructor does: Encourages students to write, instead of working mentally.*
- Pair: Discuss your answer with your neighbor, do pros and cons analysis of your algorithms.
  - *Students do: (i) Identify parts of the answer that they have missed out. (ii) Discuss which answer is better; do pros-cons analysis if there are multiple solutions.*
  - *Instructor does: (i) Walks around the class to get a feel of student solutions. (ii) Gives comments where necessary, to ensure that discussion is on-track.*
- Share: Participate in discussion of your solution and others.
  - *Students do: (i) Share their own solution. (ii) Critique other's solutions.*
  - *Instructor does: Discusses (i) What are all the essential parts in the answer? (ii) Pros-cons of various solutions given by students.*
- This TPS activity led to a discussion of various sorting algorithms.

TPS in CS 101: Example 2 (design)

- Write a program to manage your ‘Contacts’ information.
  - You need to store the following information about each contact – Name, Phone number, Email id.
  - You need to provide functions to – Input, Lookup, Update and Delete – information.

- Think: How will you store the information? Write the C++ class declarations for the data structures.

- Pair: Discuss with your neighbor’s answer and agree on the class declarations. Together, write the code for the functions.

- Share: Participate in discussion of your solutions and others.

DIY - Resource Sheet

- Look at the *TPS-activity-constructor* resource sheet handout given
  - Download from www.et.iitb.ac.in/TeachingStrategies.html

- Think (Individually): Do Part 1 of the handout
  - Write questions for one TPS activity in your course [~3 Minutes]

- Pair (with your neighbor): Do Part 2 of the handout
  - Get feedback on your TPS activity [~2 Minutes]

- Share: Get more ideas by listening to TPS activities of others

Audience – TPS activities

- Note in text file

Summary of TPS setup guidelines

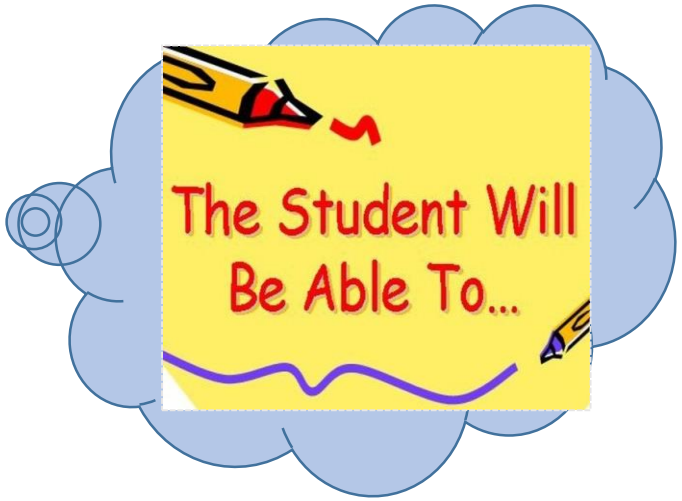
Three points to keep in mind:

1. Ensure that there is a clear ‘deliverable’ for each phase. This drives the action in that phase

2. Ensure that the phases are logically connected. They should use the output of one phase in next

3. Ensure that there is sufficient time for each phase
   Too little → Frustration; Too much → Boredom
   Move on when 80% of the class has finished

Summary - Triangle of effective learning

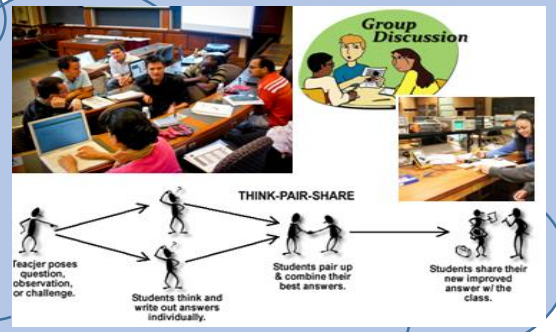


Learning Objectives

Assessment

Teaching Learning Process

Instructional activities



Thank you

- Slides, TPS resource sheet, and video are up on:
  - IDP-ET website: www.et.iitb.ac.in/TeachingStrategies.html

- Other such talks:
  1. Google - Sridhar Iyer, IIT Bombay
  2. Get to my web page - www.cse.iitb.ac.in/~sri
  3. Click on ‘Talks’