

Innovative Methods for Teaching of Mechanical and Civil Engineering Engineering Courses

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Students learn in many ways - by

- ▶ seeing and hearing;
- ▶ reflecting and acting;
- ▶ reasoning logically and intuitively;
- ▶ memorizing and visualizing and drawing analogies and
- ▶ building mathematical models

Teaching methods also vary:

- ▶ Some instructors lecture,
 - ▶ others demonstrate or discuss;
 - ▶ some focus on principles and others on applications;
 - ▶ some emphasize memory and others understanding.
- ▶ How much a given student learns in a class is governed in part by that student's native ability and prior preparation but also by the compatibility of his or her learning style and the instructor's teaching style.

- ▶ **Mismatches exist** between common learning styles of engineering students and traditional teaching styles of engineering professors. In consequence, students become bored and inattentive in class, do poorly on tests,
- ▶ **Professors, confronted by low test grades**, unresponsive or hostile classes, poor attendance and dropouts, **think something is not working**;

We will explore:

1. Which aspects of learning style are particularly significant
2. Which learning styles are preferred by most students ?
3. What can be done?

Dimensions of Learning Style

- ▶ Learning in a structured educational setting is a two-step process: 1. Reception, 2. Processing of information (learning).
- ▶ A learning-style model classifies students according to where they fit on a number of scales pertaining to the ways they receive and process information.

Models of Learning

Learning style is defined by answers to five questions:

1. Type of information a student prefer to perceive: **sensory** - sights, sounds, physical sensations, or **intuitive**
2. Channel from it is effectively perceived : **visual** - pictures, diagrams, graphs, demonstrations, or **auditory** - words, sounds
3. With what “information organization” one is comfortable : facts and observations are given, principles are inferred **inductive**, or principles are given, consequences and applications are inferred **deductive**
4. Way he/she prefer to process the information : **actively** - through engagement in physical activity or discussion, or **reflectively /passively** - through introspection
5. Progress toward understanding is effective : **sequentially** - in continual steps, or **globally** - in large jumps, holistically

Teaching style is defined in terms of answers to five questions:

1. What type of information is emphasized by instructor?
concrete - factual, or **abstract** - conceptual, theoretical.
2. What is mode of presentation?
visual - pictures, diagrams, films, demonstrations, or **verbal** - lectures, readings, discussions.
3. What is Organization of presentation?
inductively - phenomena leading to principles, or **deductively** - principles leading to phenomena?
4. What is presentation induced student participation?
active - students talk, move, reflect, or **passive** - students watch and listen.
5. What type of perspective is used in the presentation?
sequential - step-by-step progression (the trees), or **global** - context and relevance
6. Thus, teaching styles are:
concrete, . . . , global

The hypothesis: Engineering instructors who adapt their teaching style to include **both poles of each teaching style** are **popular teachers** !

1. **Visual and Auditory Learners:** As the name suggests.

A study carried out by the Socony-Vacuum Oil Company:

- ▶ students retain 10 percent of what they read,
- ▶ 26 percent of what they hear,
- ▶ 30 percent of what they see,
- ▶ 50 percent of what they see and hear,
- ▶ 70 percent of what they say, and
- ▶ 90 percent of what they say as they do something.

Examples of Teaching methods:

1. **Concrete:** Telling facts, data, doing experiments: examples → parameters values of transistors, transistors are current amplifiers, performing an experiment to obtain I_c v/s V_{ce} characteristics.

2. **Abstract:**

$$f = am$$

$$v = ut + \frac{1}{2}at^2, v^2 - u^2 = 2as$$

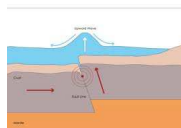
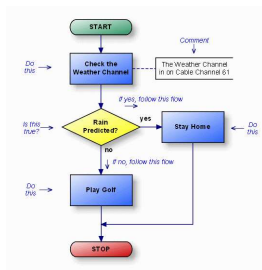
$$y = ax + b$$

$$x + y + z = 10, x - y - z = 20,$$

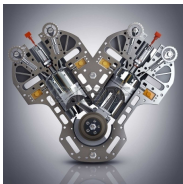
$$2x + y - 5z = 30$$

$$\frac{dy}{dx} = ax^2$$

3. **Visual:** drawing a flow-chart for some thing, explaining through diagrams, showing a video of assembling of computer hardware.



Examples of Teaching methods ...



4. **Verbal/auditory:** the standard way of lecturing
5. **Inductive:** Use observable phenomena to explain: Why?



6. **Deduction:** If instead of so many boggies there is one heavy boggy in train whose size is equal to single boggy, but weight is equal to entire train, will the engine able to pull the boggy? (Y/N, Why?)
7. **Active:** Doing experiment, learning by identifying in the graph plotted, is active learning. Also, asking a question during the class teaching, like, "Why"? And, then let the students of each bench discuss about the answer among themselves, is also active learning.

8. **Passive:** The regular class teaching is passive. The students reason about what the teacher told, and each absorb the material in their own way.
9. **Sequential:** The lecture topic when presented in logically ordered progression, i.e., next topic or discussion requires the understanding of previous, leads to sequential learning. It is common and results to make good engineers.
10. **Global:** When a problem is assigned to students, for which they spend time in days or weeks, and then discover a solution in full-form, as partial solution has no meaning, like in **chess game, sudoku, puzzle solving**. These are examples of teaching using global method and correspondingly, the learning acquired is also called global. The global teaching and learning makes great theoreticians and researchers !!

1. **Email, groups**
2. **Presentation:** through PP, Beamer (Linux), Moodle
3. **Web-conferencing:** DimDim, WebEx, CourseLab
4. **DimDim:**
 - ▶ DimDim Provides free web conferencing service where users could share desktops, show slides, collaborate, chat, talk and broadcast via webcam.

- ▶ Dimdim can be integrated with the e-learning platforms Moodle, Claroline



5. Moodle

- ▶ Moodle (acronym for Modular Object-Oriented Dynamic Learning Environment) is a free software e-learning platform, also known as a Learning Management System, or Virtual Learning Environment (VLE).
- ▶ As of June 2013 it had a user base of 83,008 registered and verified sites, serving 70,696,570 users in 7.5+ million courses with 1.2+ million teachers.
- ▶ Moodle was developed to help educators create online courses with a focus on

interaction and collaborative construction of content.

6. CourseLab

- ▶ CourseLab is a powerful, yet easy-to-use, e-Learning authoring tool that offers a programming-free WYSIWYG environment for creating high-quality interactive e-Learning content that can be published on the Internet, and Learning Management Systems (LMS).
- ▶ CourseLab is available at <http://courselab.com/en.courselab.com/samples/Electro/8/start.html>

- ▶ Following Mechanical Engineering Open course-ware are available at <http://ocw.mit.edu/courses/mechanical-engineering/>
 - How and Why Machines Work
 - Mechanics & Materials I
 - Mechanics and Materials II
 - Engineering Dynamics
 - Modeling Dynamics and Control I
 - Dynamics and Control I (Spring 2007)
 - Dynamics and Control I (Fall 2007)

Dynamics and Vibration (13.013J)

Dynamics and Control II
Systems, Modeling, and Control II

Modeling Dynamics and Control II

Design and Manufacturing I

Design and Manufacturing II

Design and Manufacturing II

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Similarly it exists for Civil Engg. and others