Academic excellence through quality technical education: Challenges and opportunities

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Inter-Disciplinary Program in Educational Technology
IIT Bombay

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Our goals as educators

We want students to learn:

- Content

  how does it all fit together, hierarchy of concepts

- Engineering “abilities’

  complex problem solving, designing experiments, making predictions, checking solutions

- Attitudes and skills

  communication, ethics, teamwork, social responsibility

Our goals as educators

We also need to fulfill:

- Prepare students for the globalized 21st century world
- Make sure our students are employable
- NBA criteria
- Possibly target ABET criteria, Washington accord
- …

Challenges and solutions

Teaching-learning scenario

What did the teacher do?

- Explained logic circuits using truth table and Boolean expressions.
- Solved multiple problems to find Boolean expression for given logic diagrams, and vice-versa.

What did students do?

- Studied all gates.
- Solved number of problems related to finding of Boolean expression for logic diagram and vice-versa.

What were exam questions?

- Real life scenario was given in which students were supposed to identify the gates, draw logic diagram and write Boolean expression.

What was the result?

- Most students were not able to solve this problem
- Students unhappy; teacher unhappy.

Who's right?

Students' comment:

The question was out of syllabus. We have not done such problems in the class.

Teacher's comment:

The question is simple since students know truth table for gates. They just have to apply logic to the given scenario and solve the problem.

Vote

1) The teacher is right, but not the students.
2) The students are right, but not the teacher.
3) Both are in fact right.

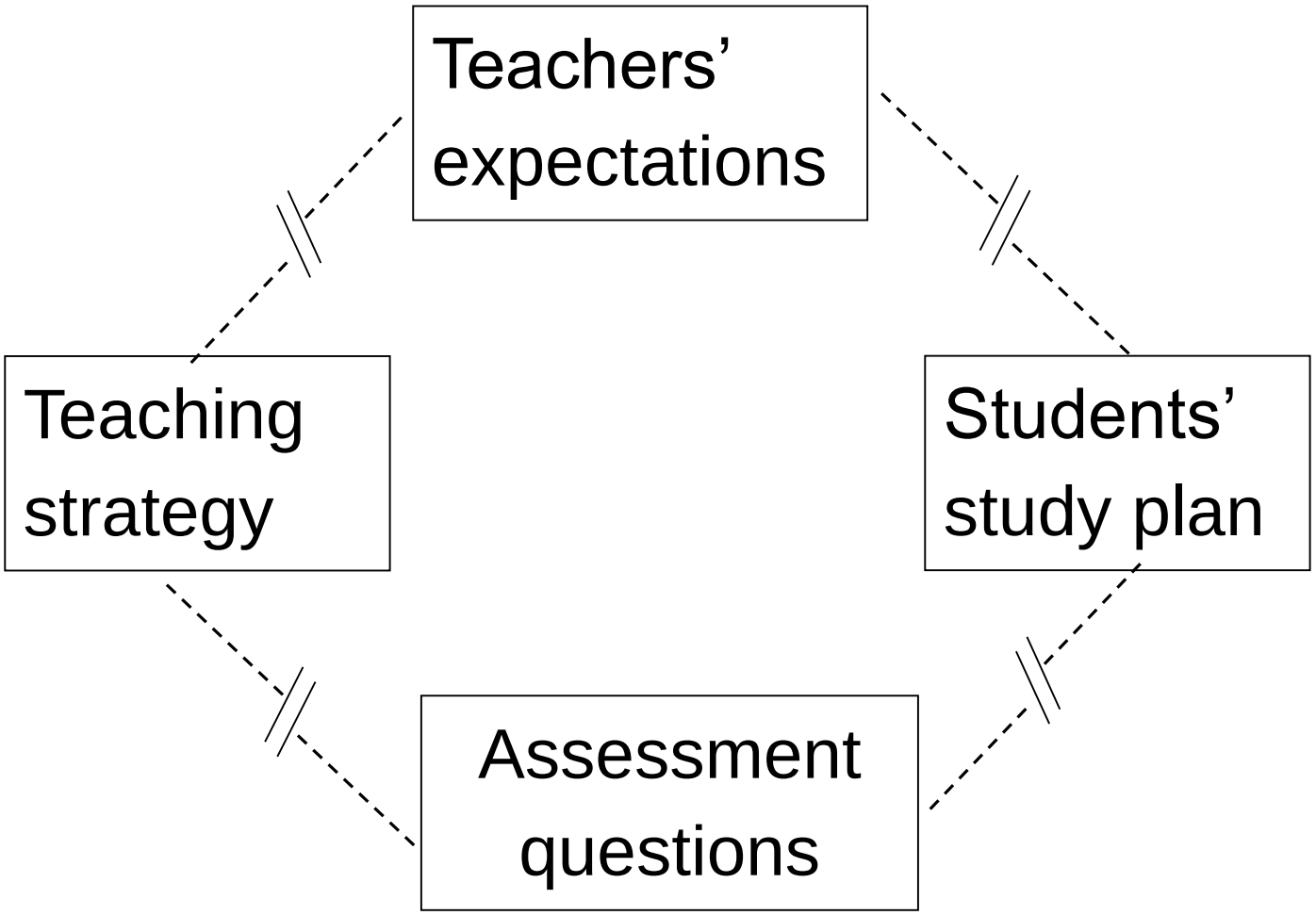
Both are right … but what went wrong?

Teachers expectations not conveyed to students.

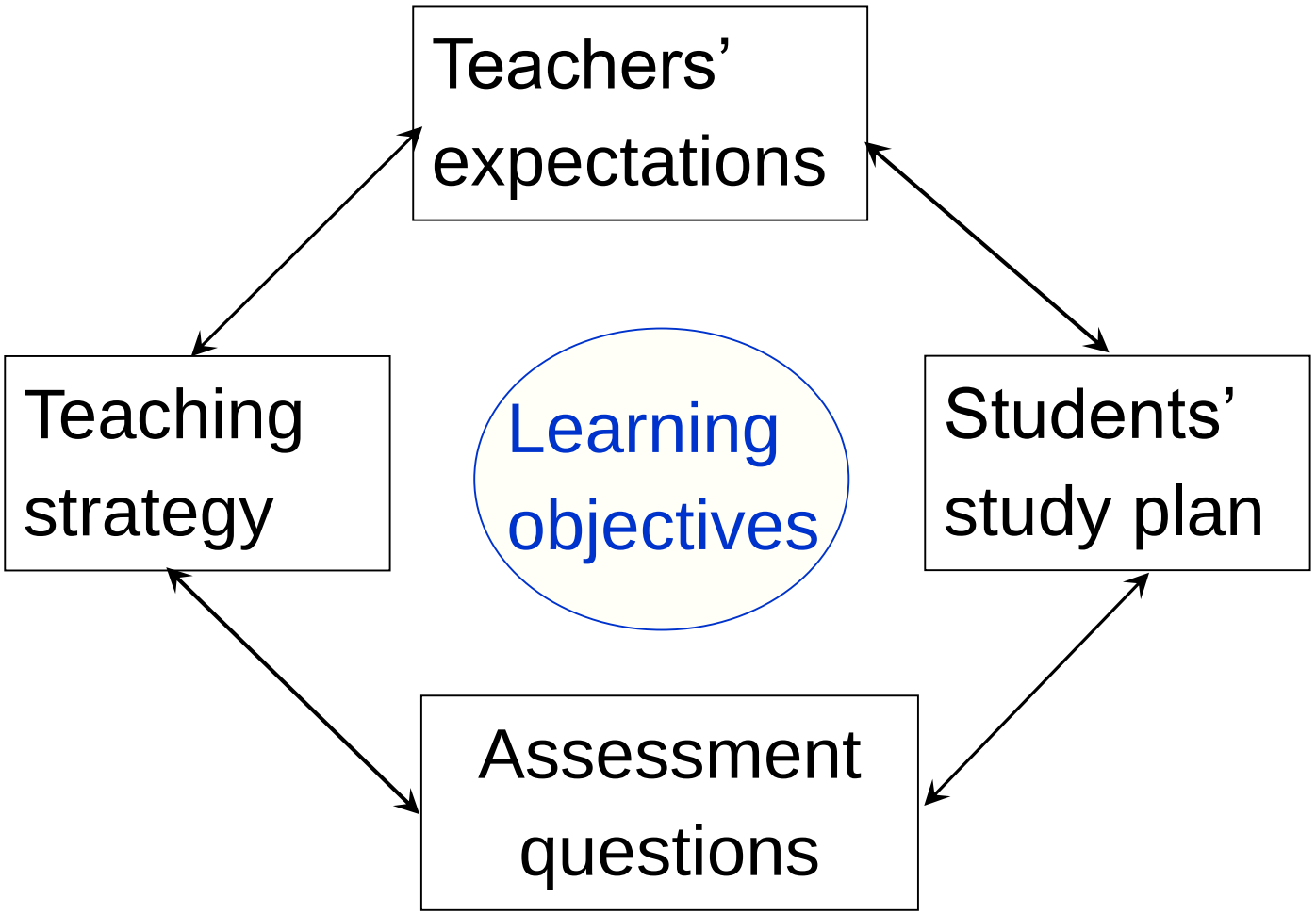
Students understanding not clear to teachers.

Lack of alignment: goals, strategies, assessment

Challenge #1: Mismatch



Addressing the challenge



From syllabus …

Today's class	**Description from syllabus**
Section 2.3 from textbook	*Logic gates* AND, OR, NOR, NAND gates, logic diagram, Boolean expressions, gate combination

From syllabus … to learning objectives

Today's class	Description from syllabus	Learning Objective **On completion of this class, the student will be able to:**
Section 2.3 from textbook	*Logic gates* AND, OR, NOR, NAND gates, logic diagram, Boolean expressions, gate combination	Draw symbol of logic gates. Write truth table of AND, OR, NOR, NAND gates. Draw logic diagram for given mathematical expression. Calculate outputs for logic gate combinations. Solve real-life problem by identifying logic gate combination

From syllabus … to learning objectives

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Precise, measureable

Why learning objectives?

Learning objectives will help us answer:

- What knowledge, skills, attitudes do we want students to develop?
- How should we structure the content of your material?
- What resources and strategies should we use in our instruction?
- How should we assess the students' learning?

Learning: systematic process

Teaching: systematic process

Assessment: Clear, fair, accurate

What is a learning objective?

Indicates specific measurable performance outcome of learner

Recall –

On completion of this class, the student will be able to:

- Draw symbol of logic gates.
- Write truth table of AND, OR, NOR, NAND gates.
- Draw logic diagram for given mathematical expression.
- Calculate outputs for gate combinations.
- Solve real-life problem by identifying logic gate combination.

Is this a valid learning objective?

Students will know how logic gates work.

VOTE - 1) Yes 2) No

Is this a valid learning objective?

Students will know how logic gates work.

VOTE - 1) Yes 2) No

Is this a valid learning objective?

Students will know how logic gates work.

How will you measure?

VOTE - 1) Yes 2) No

The “knowing” is inside students’ head.

Is this a valid learning objective?

Students will be able to understand the function of logic gates.

VOTE - 1) Yes 2) No

Is this a valid learning objective?

Students will be able to understand the function of logic gates.

VOTE - 1) Yes 2) No

What precisely do you mean by "understand?"

Different interpretations -

1) Students should be able to describe function of given logic gate.

2) Students should be able to convert the logic diagram to a mathematical expression.

2) Students should be able to apply the function of a gate to solve a real-life problem.

Is this a valid learning objective?

Students will be able to understand the function of logic gates.

VOTE - 1) Yes 2) No

What precisely do you mean by "understand?"

VOTE -

1) Students should be able to describe function of given logic gate.

2) Students should be able to convert the logic diagram to a mathematical expression.

2) Students should be able to apply the function of a gate to solve a real-life problem.

Is this a valid learning objective?

- Students will appreciate real-life potential of logic gates.

VOTE -- 1) Yes 2) No

Is this a valid learning objective?

- Students will appreciate real-life potential of logic gates.

VOTE -- 1) Yes 2) No

How can we measure if students "appreciate"?

Is this a valid learning objective?

- Students will appreciate real-life potential of logic gates.

VOTE -- 1) Yes 2) No

How can we measure if students "appreciate"?

Constructing learning objectives

Indicates specific measurable performance outcome of learner

DON'T	Instead **DO**	Need to be
▪ Understand logic gates ▪ Know how logic gates work ▪ Appreciate potential of logic gates	Formulate using "action" verbs: identify, list, describe, explain, solve, analyze, design, compare	Specific and measurable

Is this a valid learning objective?

- Give lecture on function of logic gates.

1) Yes 2) No

- Show visualization of how logic gates work

1) Yes 2) No

Is this a valid learning objective?

- Give lecture on function of logic gates.

1) Yes **2) No**

- Show visualization of how logic gates work

1) Yes **2) No**

Learning objectives should be concerned with learners' actions, not teacher's.

Constructing learning objectives

Indicates specific measurable performance outcome of learner

DON'T	Instead **DO**	Need to be
• Understand logic gates • Know how logic gates work • Appreciate potential of logic gates	Formulate using "action" verbs: identify, list, describe, explain, solve, analyze, design, compare	Specific and measurable
• Lecture on logic gates • Show visualization of logic gates function	The student will be able to …	Concerned with learner

How to write learning objectives

Start with: **The student should be able to …**

Use **action verbs**

identify, list, describe, draw, explain, solve, analyze, compare, design
(avoid understand/know)

How to incorporate “difficulty” of cognitive level in learning objectives

Simple, less effort

Draw symbol of logic gates.

Write truth table of AND, OR, NOR, NAND gates.

Draw logic diagram for given mathematical expression.

Calculate outputs for gate combinations.

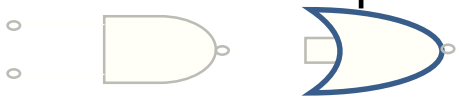
Solve real-life problem by identifying logic gate combination.

Design circuits for math operations using gates.

Complex, demanding

Formal theory: Hierarchy of cognitive levels
Revised Bloom’s Taxonomy – 6 levels

Hierarchy of cognitive levels

Level	Description	Action verbs	Example Q
Recall	Recognize, recall facts	cite, label, list, define, quote, identify, state	Define the AND operation using a mathematical expression. Draw symbol for OR gate
Understand	Grasp meaning, explain, interpret, translate, paraphrase	explain, rephrase, convert, give examples, summarize translate, illustrate reword, interpret, Paraphrase	Explain why NAND and NOR gate are called universal gates. Give an example of …
Apply	Use knowledge in a new situation. Involves rules, methods, laws, principles	Apply, relate, solve, classify, predict calculate, prepare	Calculate the output of: 

Hierarchy of cognitive levels

Level	Description	Action verbs	Example Q
Analyze	Separate whole into parts until structure of whole and relation betwn parts is clear.	analyze, infer examine, ascertain, associate, dissect discriminate,	Get the output given by the following equation: A+AB+AB
Evaluate	Judge value based on criteria, decision making.	assess, conclude, decide, contrast, compare, evaluate	Decide if it is better to use NAND or NOR gate for goal
Create	Combine parts to make (new) whole, creative behaviours, propose plans	design, combine, devise, modify, plan, extend, compile, generalize	Design a half adder circuit using AND, OR, NOT gates.

To summarize -

Challenge (#1)

Mismatch between teacher expectation, student study plan, exam questions

Address

Write valid learning objectives for course, module, lecture unit.

Set exam questions aligned to learning objectives

Benefits

Our goals met – deep content, engineering skills

NBA criteria met

Students' employability increases.

More challenges ….
and some solutions

Challenge of student engagement

How many of you have faced this in your class:

Students not engaged, bored, tuned out …

1) All the time!
2) Often
3) Sometimes
4) Never

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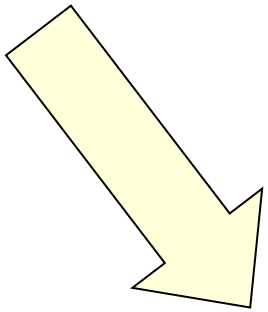


Leading to decrease in learning

Examples – challenge and addressal

Effect of Think-Pair-Share in a Large CS1 Class: 83% Sustained Engagement

Challenge: Engage students in a 1st year programming class

Strategy: Think-Pair-Share

Program Visualization as a Pivotal Tool Of Instruction In a Large Resource Constrained Classroom to Teach Novice Learners Computer Programming wi

Challenge: Student learning of basic programming concepts

Strategy: Students interact with a program visualization

Examples – challenge and addressal

3Pf: Prepare-Present-Positive feedback –

An Active Learning Approach for Low Achievers

Challenge: Low achieving students lack confidence, poor communication skills

Strategy: Active learning approach focused on low achievers

Demystifying Networking: Teaching Non-Majors via Analogical Problem-Solving

Challenge: Non-CS majors find details of n/w course daunting

Strategy: Use real life analogies and group problem solving

Strategies based on education research

Peer instruction w/ clickers

Think-Pair-Share

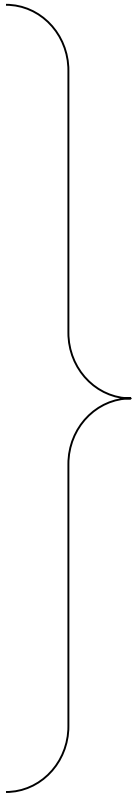
Collaborative problem solving

Just-in-time-teaching

Use of computer-visualizations

Concept maps

…



Not just tool, but also pedagogy

Converting challenges to opportunities through Educational Technology

Converting challenges to opportunities through Educational Technology

Which of the following would you consider to be educational technology?

1) Use ICT tools – computers, WWW, ppt, LMS, wiki
2) Design guidelines for an educational game
3) Plan group activities to be conducted in a classroom (such as collaborative project)
4) All the above

Educational Technology is technology ***of*** education

as well as

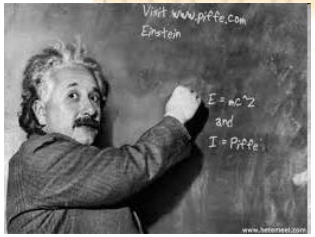
technology ***for*** education

What is Educational Technology?

The application of methods, strategies and tools that facilitate the teaching-learning process, with a focus on current technological tools









Simply using ppt in lecture is NOT educational technology

All-round academic excellence through educational technology

- How do people learn?
- What are its implications for pedagogy and technology?

Learning

- Who is the target audience? What are the goals?
- Which teaching strategies best address above?
- What technology tools provide best advantages for above?

Course design

- How to systematically design educational material?

- Did it all work ?

Evaluation

Converting challenges to opportunities through Educational Technology

What you can do

Attend workshops : T10KT, QIP, within college …

Participate in NMEICT projects

Conduct ET action research in your class

Consider PhD in ET

Participate in faculty development workshops

- Effective teaching strategies for engg education
- Integrating educational technology in engg courses
- Research methods in ET

Offered through T10KT, IITB-QIP, other colleges …

See video tutorials on IITB ET webpage → Resources

Opportunity:

Go beyond “showing ppt”

Learn new strategies and effective ET tools,

Implement in your class

Educational Technology

An Inter Disciplinary Program at IIT Bombay

Resources

Think – Pair – Share (TPS) – Talk by Prof. Sridhar Iyer – December 2013

- TPS resource sheet: Download - [.pdf], [.docx]
- TPS session slides: Download - [.ppsx], [.pptx]
- Session Video: [will be available soon]

Conducting and Reporting an Educational Technology Research – Templates to assist in ET Research Study

- Tutorial on Conducting Educational Technology(ET) Research Study – [.pptx]
- Guidelines for conducting ET Research Study – [.pdf]
- How to use the Templates and Guidelines – Readme [.docx] [.pdf]
- Idea Proposal Template – IPT [.docx] [.pdf]
- Study Planning Template – SPT [.pptx] [.pdf]
- Paper Planning Template – PPT [.pptx] [.pdf]
- Paper Writing Template – PWT [.docx] [.pdf]

Indian Institute of Technology Bombay, Powai, Mumbai, 400076, Tel:91 22 2572 2480

Participate in NMEICT Projects

MHRD - National Mission on Education through ICT

NPTEL National Programme on Technology Enhanced Learning

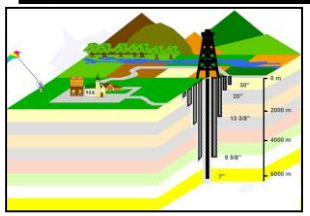
http://nptel.iitm.ac.in/

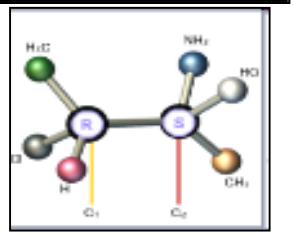
spoken-tutorial
partner with us...help bridge the digital divide

www. spoken-tutorial.org

300+ tutorials, 20 languages

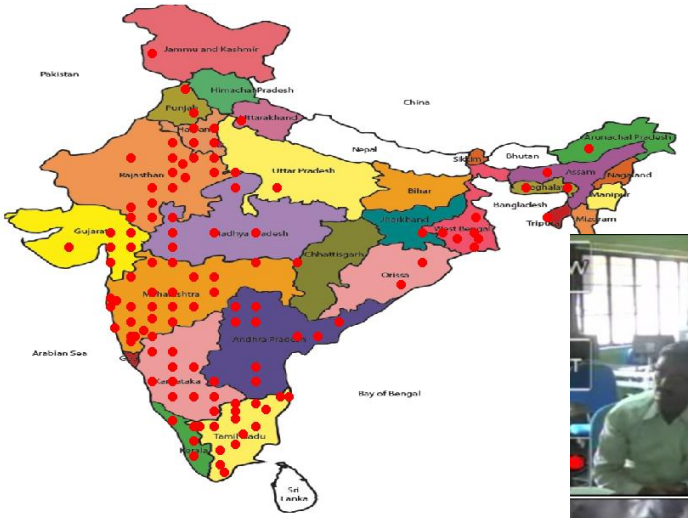
Project OSCAR
Open Source Courseware Animations Repository





http://oscar.iitb.ac.in

300 animations, simulations

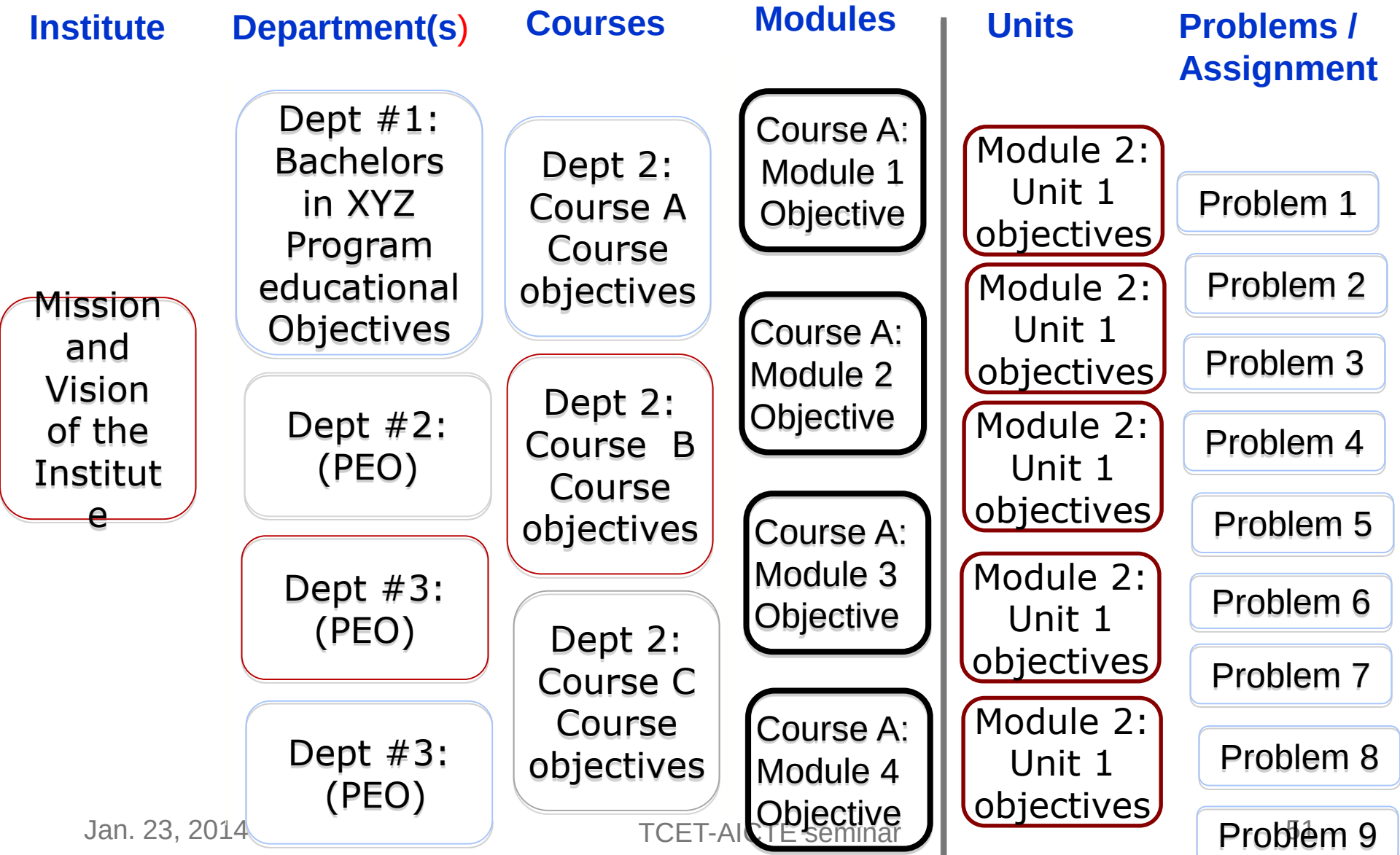


fossee

Teach 10000 Teachers

www.it.iitb.ac.in/nmeict

NMEICT - Pedagogy Project Curriculum Design



Conduct ET action research

- Research enhances teaching
- Classroom “action research” to integrate research and teaching
  - Propose a novel teaching idea (for ex., new TEL strategy)
  - Implement teaching idea in your class
  - Execute research study in your class
    - collect and analyze data
    - reflect on findings
  - Write paper for ET conference such as T4E
    - position wrt related work
    - describe rigorous methodology
    - draw claims, conclusions

Improve quality of teaching and learning

Conduct research, publish papers

Conduct ET action research

T4E 2013

Effect of Comic Strips as a Supplementary Material to Teach Computer Networks

Lakshmi Ganesh
M.E. (second year pursuing), Department of Computer Engineering
Thakur College of Engineering and Technology
Mumbai, India
lakshmiganesht@gmail.com

ICCE 2012

Interactive visualization to teach engineering design competencies

Madhuri MAVINKURVE[a]* & Sahana MURTHY[a]
[a]*Indian Institute of Technology Bombay, India*
*mavinkurvemk@gmail.com

Opportunity: Conduct a study and submit a paper to

IEEE International Conference on Technology for Education T4E

http://www.ask4research.info/t4e/2014/

IITB Educational Technology Inter-Disciplinary Programme

http://www.et.iitb.ac.in

- Started April 2010
- Ph.D. programme
- 20 Ph.D. students
- Faculty :
  - Core faculty in Educational Technology
  - CS, engineering, science, social science, design...
- Courses in ET, research methods
- R & D projects

Opportunity: *Do PhD*

http://www.et.iitb.ac.in/admissions

www.et.iitb.ac.in/node/138/

moodle IIT-GPO DBP Moodle ET Drona GoogleDrive gma

Educational Technology

An Inter Disciplinary Program at IIT Bombay

Home | Research | Academics | Admissions | People | Resources (New) | Professional Service | Calendar

Student Theses

Student Name	Guide, Co-Guide	Thesis Topic
Madhuri Mavinkurve	Sahana Murthy	Development and assesment of engineering design competencies
Yogendra Pal	Sridhar Iyer	Developing a framework for scaffolding to teach programming to Hindi learners
Atul Deshpande	Mahesh Patil	
Sachin Kamble	B. L. Tembe	Applying instructional design model and concept maps on student performance in classroom teaching of thermodynamics
Kapil Kadam	Sridhar Iyer	Computer Based Training for Improvement of Spatial skills
Eranki Kiran	Kannan Moudgalya	Development and assessment of Programming competencies through Spoken Tutorial workshops
Gargi Banerjee	Sahana Murthy	Developing a customized evaluation framework for Learning Objects
Mrinal Patwardhan	Sahana Murthy	Effectiveness of Interactive Visualizations in Engineering Education: Analyzing interactivity level of visualizations in applying knowledge
Anita Diwakar	Santosh Noronha	Development of guidelines to design, implement and evaluate Virtual Labs with quality pedagogy
Anura Kenkre	Sahana Murthy	Development the scientific ability of modeling using learning objects
Vikram Vincent	Ravi Poovaiah	
Aliabbas Petiwala	Kannan Moudgalya, Pushpak Bhattacharya	Automation in the Construction of Syllabus Conforming Customized Textbooks from Lecture Transcripts

Contact Us

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Phone(office): +91-022-2576-4820

ET Research Areas at IITB

- **Pedagogy for technology enhanced learning**.

  Innovative pedagogies and assessment

  Learner-centered strategies

  Technology integration for teachers

- **Development of technology-enhanced learning environments**

  Visualizations - animations, simulations

  ITS and adaptive learning systems

- **Discipline based education research**

  Physics, CS, Electronics

An Appeal to Principals, Deans, AICTE…

An Appeal to Principals, Deans, AICTE…

Encourage your faculty to pursue Ph.D. in ET.

Recognize ET as a valid discipline for PhD

It is a tremendous opportunity towards achieving academic excellence in quality technical education

Thank you!

Contact:

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Phone: +91-022-2576-4820

Info: http://www.et.iitb.ac.in

(PhD admissions, workshops, resources)