Effective Teaching Techniques Using MATLAB and Simulink

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Outline

Most images in this presentation are borrowed from open web resources with due gratitude and acknowledgement
OUTLINE

• Motivation

• What involves Engineering Education?

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Motivation

What involves Engineering Education?

Building practice into theory

Few case studies

- General computation
- Simulating dynamical systems
- Building approximate linear models
- Frequency-domain (spectral) analysis
- Handling uncertainties and parameter estimation
High School Education

Equations
Pure sciences
Trained for solving exact and pure problems

Engineering Education: Current Practice

- Maths & Sciences taught as pure subjects - zero emphasis on applied aspects!
- Theory courses followed up with lab sessions across semesters
- Pure software courses (e.g., in MATLAB, ASPEN, etc.)
- Very little emphasis on intuition and perspectives
- Drawbacks:
  - Cannot place mathematics and sciences in context
  - Disconnect between theory and practice
  - Theory is not understood and practice is boring
  - Graduation without realisation
Risks

A live in concert tonight: The Mathematics
Risks

What Happened to Intuition, Practicality?
WHAT HAPPENED TO INTUITION, PRACTICALITY?

SOLVING EQUATIONS - BY TBILLINGS

3x+7=7
We are going to solve this equation for x.

3x+7 = 7
-7 -7
3x = 0
3x/3 = 0/3...

1st, we subtract 7 from each side of the =. Next, we divide both sides by 3 ...

3x+7 = 7
-7 -7
3x = 0
3x/3 = 0/3
x = 0

Oh man, I did that whole problem for nothing!!!
WHAT HAPPENED TO INTUITION, PRACTICALITY?

DAIRY ENGINEERING - BY NANSCLARK

In the engineering lab this week, I figured out how you can get three times as much milk from your cows!

How can that possibly be true? I run the most productive dairy in the state!

Well, today is your lucky day! Turns out, all it takes is a simple calculation!

Okay, first assume you have a spherical cow radiating milk isotropically...

What calculation?

END RESULT
END RESULT

www.olaalaa.com
**End Result**

![Cartoon of a job interview with the highlighted text: "I see you did well in school, but what real-world skills do you have?"

**Engineering Education: What is needed?**
Show how math and sciences, blend and get into action.

Teach how probability and statistics are useful!
**Engineering Education: What is needed?**

Show how math and sciences, blend and get into action. Teach how probability and statistics are useful!

1. How do equations get into action! (Equations?)
2. How to deal with uncertainties?
3. How to estimate?

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**Connecting Concepts with Details**

- Concepts Perspectives
- Simulations / Experimental Demos
- Theory (Details)
- Applications
To Remember

A lecture is worth thousand reads
To Remember

A lecture is worth thousand reads

A picture is worth thousand words

Simulation is worth thousand lectures!
TO REMEMBER

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A picture is worth thousand words

Simulation is worth thousand lectures!

Healthy blend of technology, analogies, similitudes, theory and practice makes a complete package

ROLE OF SIMULATIONS

THEORY

PRACTICE
ROLE OF SIMULATIONS

EXPERIMENTS

PRACTICE

THEORY

SIMULATIONS

THEORY

EXPERIMENTS

PRACTICE
What can simulations offer?

- Powerful reinforcements and supplements for theory
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- Building highly effective motivational and practical case studies
- Excellent tools for zones where theory fears to tread
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- Powerful reinforcements and supplements for theory
- Building highly effective motivational and practical case studies
- Excellent tools for zones where theory fears to tread
- Safe and effective substitute for experiments
- Opportunities for innovation and testing
TEACHING PARADIGMS

APPLICATIONS, NATURAL PHENOMENA
Engineering, Medicine, Social Sciences, Law, Business, etc.
TEACHING PARADIGMS

SIMULATIONS, EXPERIMENTS
Practicing Aspects, Realities, Cross-validation, Testing, Design, Discoveries

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- **THEORY**
  - Abstraction, Fundamentals, Equations

- **INTUITION**
  - Concepts, Ideas, Perspectives

- **SIMULATIONS, EXPERIMENTS**
  - Practicing Aspects, Realities, Cross-validation, Testing, Design, Discoveries

- **APPLICATIONS, NATURAL PHENOMENA**
  - Engineering, Medicine, Social Sciences, Law, Business, etc.

CASE STUDIES

- Elementary computing
  - *MATLAB*

- Understanding and simulating dynamical systems
  - *MATLAB and SIMULINK*

- Approximating non-linear systems through linearisation
  - *MATLAB and SIMULINK*

- Signal estimation and Fourier transform
  - *MATLAB*

- Simulating uncertainties and parameter uncertainties