Instructional Laboratories Why?

Lyle D. Feisel
Dean Emeritus
State University of New York at Binghamton

Why DO we send our students to the laboratory?

- Because our professors sent us to the laboratory?
- To ask Nature a question?
- To achieve some learning objectives?

ABET/Sloan Colloquy

January, 2002

- The promise of learning at a distance
- The challenge of learning at a distance
  - Especially the laboratory experience
- Question:
  - How do we know if a distance laboratory experience is successful?
- A bigger question:
  - How do we know if ANY laboratory experience is successful?

The Questions

What are the fundamental learning objectives of the instructional laboratory experience?

Or more directly stated:

What do we expect a student **to be able to do** after they have completed the laboratory experience?

The Fundamental Objectives for Engineering Instructional Laboratories

1. Use sensors and instruments to make measurements
2. Demonstrate the validity and limitations of models
3. Design experiments
4. Analyze data
5. Design and test devices and systems
6. Learn from failure

The Fundamental Objectives for Engineering Instructional Laboratories

- 7. Develop creativity
- 8. Develop psychomotor skills
- 9. Instill safe habits
- 10. Develop communication skills
- 11. Develop teaming skills
- 12. Instill ethical behavior
- 13. Develop sensory awareness

Which objectives need a physical presence?

1. Instrumentation
2. Models
3. Experiment
4. Data Analysis
5. Design
6. Learning from Failure
7. Creativity
8. Psychomotor
9. Safety
10. Communication
11. Teamwork
12. Ethics in the Lab
13. Sensory Awareness

Which objectives need a physical presence?

1. Instrumentation
2. Models
3. Experiment
4. Data Analysis
5. Design
6. Learning from Failure
7. Creativity
8. **Psychomotor**
9. **Safety**
10. Communication
11. Teamwork
12. Ethics in the Lab
13. **Sensory Awareness**

Three Conclusions

1. It is essential that the instructional objectives of the laboratory exercise be explicitly determined.
2. Ninety percent of the objectives can be achieved in a virtual laboratory experience.
3. Remote laboratories provide no educational advantage over a virtual laboratory and in some cases are limiting.

Thank You

Reference Slides

1. Instrumentation

- Apply appropriate sensors, instrumentation, and/or software tools to make measurements of physical quantities.

2. Models

- Identify the strengths and limitations of theoretical models as predictors of real world behaviors. This may include evaluating whether a theory adequately describes a physical event and establishing or validating a relationship between measured data and underlying physical principles.

3. Experiment

- Design an experimental approach, specify appropriate equipment and procedures, implement these procedures, and interpret the resulting data to characterize an engineering material, component, or system.

4. Data Analysis

- Demonstrate the ability to collect, analyze, and interpret data, and to form and support conclusions. Make order of magnitude judgments, and correctly use measurement unit systems and conversions.

5. Design

- Design, build, or assemble a part, product, or system, including using specific methodologies, equipment, or materials; meeting client requirements; developing system specifications from requirements; and testing and debugging a prototype, system, or process using appropriate tools to satisfy requirements.

6. Learn from failure

- Identify unsuccessful outcomes due to faulty equipment, parts, code, construction, process, or design, and then re-engineer effective solutions.

7. Creativity

- Demonstrate appropriate levels of independent thought, creativity, and capability in real-world problem solving.

8. Psychomotor

- Demonstrate competence in selection, modification, and operation of appropriate engineering tools and resources.

9. Safety

- Recognize health, safety, and environmental issues related to technological processes and activities, and deal with them responsibly.

10. Communication

- Communicate effectively about laboratory work with a specific audience, both orally and in writing, at levels ranging from executive summaries to comprehensive technical reports.

11. Teamwork

- Work effectively in teams, including structure individual and joint accountability; assign roles, responsibilities, and tasks; monitor progress; meet deadlines; and integrate individual contributions into a final deliverable.

12. Ethics in the Laboratory

- Behave with highest ethical standards, including reporting information objectively and interacting with integrity.

13. Sensory Awareness

- Use the human senses to gather information and to make sound engineering judgments in formulating conclusions about real-world problems.

The Fundamental Objectives

1. Instrumentation
2. Models
3. Experiment
4. Data Analysis
5. Design
6. Learning from Failure
7. Creativity
8. Psychomotor
9. Safety
10. Communication
11. Teamwork
12. Ethics in the Lab
13. Sensory Awareness