ADQUISICIÓN DE COMPETENCIAS EXPERIMENTALES EN INGENIERÍA
CONTRIBUCIÓN DE LOS LABORATORIOS REMOTOS

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Paraná – Entre Ríos – Argentina
13 Septiembre 2017  Slide 1
Estrutura

• Laboratórios presenciais (*hands-on*), **remotos** e virtuais (simulação)
• Educação (ensino & aprendizagem) em Engenharia (EE)
• Atividades e competências laboratoriais
• Estratégia(s) de E&A baseadas em laboratórios **remotos** e virtuais
  • Exemplo na área da Engenharia Eletrotécnica: circuitos elétricos e electrónicos
• Conclusão
Laboratórios presenciais (*hands-on*), remotos e virtuais (simulação)

- **Real**
- **Local**
- **Remoto**
- **Simulado**

- **Simulador**
- **Hands-on**
- **Lab. remotos**
- **Lab. virtuais**

- **Critério**
  - Tipo de acesso
    - Local
    - Remoto
  - Natureza
    - Real
    - Simulada

- **Comp. experimental vs. tipo de lab.**
  - Ma & Nickerson (2006)
EE: Modelo ensino/aprendizagem

Royal Society motto 'Nullius in verba' (1660):
“...express the determination of its Fellows ... to verify all statements by an appeal to facts determined by experiment.”

Max Planck: “An experiment is a question which science poses to Nature and a measurement is the recording of Nature’s answer.”

Lyle Feisel (2005): “The value of combining theory and practice traced back to the 1st engineering school in the US, the US Military Academy, founded at West Point, NY in 1802.”
EE: Modelo ensino/aprendizagem

Séc. XX - Anos 70-80
Um novo ator:
O computador pessoal!

Simulações em computador
Meados do Séc. XX

Um PC por bancada laboratorial

Finais do Séc. XX
Inícios do Séc. XXI
EE: Modelo ensino/aprendizagem

Instrumentação controlada por computador
Séc. XX - Finais dos anos 60

Controlo via Internet
Séc. XX - Década de 90

Second-Best to Being There (SBBT)
Aktan, Bohus and Shor (1996)
Hands-on, simulated, and remote labs: A literature review
Ma and Nickerson (2006)

Developing the TriLab
Abdulwahed and Nagy (2010)

Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research
Brinson (2015)

The Impact of Remote and Virtual Access to Hardware upon the Learning Outcomes of Undergraduate Engineering Laboratory Classes
Euan Lindsay’s PhD (2005)

Weighting and sequence of use of different lab environments in the teaching-learning process
Alves et al. (2008)
Five Major Shifts in 100 Years of EE

1. A shift from hands-on and practical emphasis to engineering science and analytical emphasis
2. A shift to outcomes-based education and accreditation
3. A shift to emphasizing engineering design
4. A shift to applying education, learning, and social-behavioral sciences research
5. A shift to integrating information, computational, and communications technology in education

Froyd, Wankat, and Smith (2012)
5. **A shift to integrating ICCT in education**
   - content delivery: television, videotape, and the Internet
   - programmed instruction: individualized student feedback
   - personal response systems (clickers)
   - computational technologies
   - intelligent tutors: second phase of individualized student feedback
   - simulations
   - games and competitions
   - remote laboratories
   - grading

Froyd, Wankat, and Smith (2012)
The Fundamental Objectives of Engineering Instructional Laboratories


The Role of the Laboratory in Undergraduate EE

The Fundamental Objectives of Engineering Instructional Laboratories

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

Feisel and Rosa (2005)
Objective 2: Models

Identify the strengths and limitations of theoretical models as predictors of real-world behaviours. 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.

P. PORTO

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Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

• Aspectos a considerar:
  • Plano curricular: objectivos e resultados da aprendizagem!
  • Recursos (materiais, infraestrutura, ambientes disponíveis, etc.)
    • Considerar tempo de aprendizagem / adaptação aos recursos disponibilizados
  • Estilos de aprendizagem e métodos de ensino
    • Diversidade!
    • Feedback constante e rápido.
  • Avaliação
    • Combinar elementos comuns e individuais. Garantir igualdade de oportunidade e níveis aproximados de dificuldade.
  • Promover trabalho colaborativo na fase de aprendizagem e independência de resultados na fase de avaliação (individual)
Recursos: Laboratórios remotos e virtuais
Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

- Exemplos na área da Engenharia Eletrotécnica: circuitos elétricos e electrónicos

VISIR@UNR: https://labremf4a.fceia.unr.edu.ar/labs/visirnet/default.aspx
Virtual Instrument Systems in Reality (VISIR)

• Ingvar Gustavsson (inspired in Max Planck):

“Experimenting could be compared to a conversation with nature. The experimenter asks and nature answers. The tricky thing is formulating a useful question and above all interpreting the answer. The only way to learn the language of nature is performing many experiments in laboratories that can be hands-on or remote.”
Virtual Instrument Systems in Reality (VISIR)
VISIR Laboratories

• Blekinge Institute of Technology (BTH), Sweden (VISIR+) (PILAR)
• University of Deusto (UD), Spain (VISIR+) (PILAR)
• FH Campus Wien University of Applied Sciences, Austria (VISIR+) (PILAR)
• Carinthia University of Applied Sciences (CUAS), Austria (VISIR+) (PILAR)
• School of Engineering – Polytechnic of Porto (IPP-ISEP), Portugal (VISIR+) (PILAR)
• National University for Distance Education (UNED), Spain (VISIR+) (PILAR)
• Indian Institute of Technology Madras (IIT-Madras), India (VISIR+) (PILAR)
• Batumi Shota Rustaveli State University, Georgia (VISIR+)
• Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil (VISIR+)
• Federal University of Santa Catarina (UFSC), Brazil (VISIR+)
• Federal Institute of Santa Catarina (IFSC), Brazil (VISIR+)
• National University of Rosario (UNR), Argentina (VISIR+)
• National University of Santiago del Estero (UNSE), Argentina (VISIR+)
• University of Hassan 1st, Morocco (VISIR+)
Global Online Laboratory Consortium

GOLC

2015
Online Lab Award

The GOLC Online Laboratory Award 2015 in the category
„Remote Controlled Lab“

is presented to

VISIR (Virtual Instrument Systems in Reality)

Submitted by:

Ingvar Gustavsson, Gustavo Alves, Thomas Fischer, Javier Garcia Zubia, Felix Garcia, Manuel Castro

Awarded during the 12th International Conference on Remote Engineering and Virtual Instrumentation (REV2015) in Bangkok, Thailand

Abul K. M. Azad
President

Michael E. Auer
Secretary General

GOLC – Mission Statement

“The mission of the consortium is the creation of sharable, online experimental environments which increase the educational and scientific value of learning which may not be accessible, scalable or efficient through traditional methods.”

This means especially:

- to encourage and support the creation of new online labs and associated curricular materials;
- to sponsor the design of an efficient mechanism for sharing, exchanging and trading access to online labs by creation of a global network of sharable experiments;
- to support communities of scholars created around online laboratories and
- to lead the evolution of an architecture that enables the sharing of online labs by unified standards.
Conclusão

• A integração de laboratórios remotos e virtuais no contexto de uma unidade curricular depende de vários aspectos:
  • Individuais: a vontade do responsável da UC (professores) e o grau de adesão dos alunos e alunas
  • Institucionais: disponibilização de recursos e suporte à sua integração

• Objectivos:
  • dotar os alunos de *mais e melhores competências experimentais*
  • permitir a realização de *mais experiências de forma sustentável*
Remote labs as **Sustainable** Learning Environments

- Economic practice + environmental protection
  - Experiments with electrical circuits
Remote labs as **Sustainable** Learning Environments

- Economic practice + environmental protection
  - Typical problem – components
    - They can be damaged!
Remote labs as **Sustainable** Learning Environments

- Economic practice + environmental protection
  - Typical problem – components – 1
  - One resistor is typically used 100-500 times and then it either gets damaged or mixed with other components and is (are) thrown away at the end of a semester.
  - One resistor has been used more than 1,000,000 times in VISIR (@UNED)
  - Savings: \( \frac{1,000,000}{500} = 2,000 \times 0.0286 = £57.2 \approx €65.3 \) (in a single component)

### Remote labs as Sustainable Learning Environments

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Remote labs as **Sustainable** Learning Environments

- Economic practice + environmental protection
  - Typical problem – components – 2
  - A simple inspection test made after an individual lab assessment exercise revealed a percentage of 30% damaged ICs (OpAmp 741). One class with 16 students. 2 ICs per student. Approx. 10 ICs were damaged (per class).
  - Savings: 10 * 0.367 = £3.67 ≈ €4.18 (in a single class)
Obrigado pela atenção!
Remote labs as **Sustainable** Learning Environments

- Economic practice + environmental protection
  - Typical problem – components