How to conduct an educational experiment.
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• Vice President Publications, IEEE Education Society

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  – Professor of Communications Systems Engineering
• Former Vice-Dean Education, UCL Faculty of Engineering Science
• Co-Director of the UCL Centre for Engineering Education
• From 2012 was involved in a cross-faculty curriculum revision exercise to introduce inter-department working and problem-based learning into the curriculum at UCL.
Goals of the Sessions

• What is Engineering Education Research?
• What theoretical approaches are available to researchers / practitioners?
• What must you consider before starting your study?
• What methodologies are commonly used to conduct studies and what must be considered?
• Some words of warning!
• Where to publish?
A spectrum of scholarship

Scholarship of teaching
  - Effective teaching
  - Scholarly teaching

Scholarship of teaching and learning

Scholarship of application

Scholarship of discovery

Scholarship of integration

Engineering education research

Classroom action research

Elements of Education Research

- Posing a problem about an issue of teaching or learning
- Studying the problem through methods appropriate to disciplinary epistemologies
- Analysing results
- Communicating results
- Getting peer review

A framework for EER

1. Review the literature
2. Identify significant, relevant RQ
3. Link to appropriate theory
4. Use proven methods, aligned to RQ
5. Interpret data
6. Disseminate generalizable findings
• Quantitative – testing theories by examining relationships between measurable variables
• Qualitative - gaining an understanding of the meaning individuals/groups give to events or processes
• Mixed Methods – integrating both quantitative and qualitative techniques not possible through one approach alone.
• **Survey Research** – Specific questions with closed answers (yes/no, likert scales) using questionnaires or structured interviews.
  – Can be cross-sectional (multiple participant types and a single point) or longitudinal (repeated at different timepoints)

• **Experimental Research** – Compare two groups with different ‘treatment’ and determine how they ‘score’ on a specific metric. Can be true- or quasi-experimental.
Approaches - Qualitative

- **Narrative Studies** – diaries, reflections etc.
- **Phenomenography** - investigating the lived experience of individuals of a specific phenomenon.
- **Ethnography** – investigating shared patterns of behaviour, language or actions in a natural setting over time.
- **Grounded Theory** – derive an abstract theory of a process from the views of participants
Approaches - Mixed

• **Convergent** – Combining data from qualitative and quantitative data collection.

• **Explanatory sequential** – using a quantitative instrument to inform a qualitative study.

• **Exploratory sequential** - using a qualitative study to inform the design of a quantitative instrument.
Before the Study
Research Ethics

• Educational research almost always involved people

• Principles
  – Voluntary informed consent, with right to withdraw and defined purpose.
  – Online data is generated by individuals.
  – Privacy and secure data storage - confidential and anonymous where at all possible.
  – Transparency with participants.

• A statement that problem you wish to consider and setting clear goals for the study.

• The purpose of this study is to........
  – *Qualitative* - Focus on a single phenomenon, concept or idea
  – *Quantitative* – identify the variables and connections
  – Use open action verbs, *understand, develop, explore, discover*
  – Provide limits to the study – who, where etc.
  – You may also want *(eventually)* to say how – but we’ll come to this later!
Write and Share a Purpose Statement for your Research

GROUP ACTIVITY
10 Minutes
Purpose Statement

• A statement that problem you wish to consider and setting clear goals for the study.

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Research Questions

• **Qualitative** - Ask one of two central questions with at most 5 sub-questions
  – Report (narrative research)
  – Describe the experience of (phenomenology)
  – Discover (grounded theory)
  – Understand, Explore (ethnography)

• **Quantitative** – State the hypothesis being tested
  – Variables -> Compare, relate or describe
Write and Share your Research Questions

GROUP ACTIVITY
15 Minutes
Methodologies - Quantitative

• Survey
  – Population – How many are involved
  – Sampling – How are they selected?
  – How many questions? Make sure they are not leading!
  – What other data do you need to collect?
Methodologies - Quantitative

• Experiment
  – Can two groups be identified – is this ethical?
  – What dependencies are there?
  – Remember:
    • most educational experiments do not fully control relevant variables
    • even large-scale educational experiments cannot assure that samples
      are fully representative of populations, so strictly cannot be generalised;
  – Is it really an experiment
A guide to using experiments to inform education
Methodologies - Qualitative

- Interviews / Focus Groups
  - Interviews are good for depth
  - Focus group provide discussion and may converge on a consensus
  - Sampling – who will be involved?
  - Structured / Semi-structured / Unstructured?

Methodologies - Qualitative

• Textural Analysis
  – Using written work or specific written tasks (diaries, reflections etc.) to gain an understanding.

Methodologies - Qualitative

• Observations
  – ‘Natural’ environment
  – Can be participant or non-participant
  – Can you even be an unobtrusive observer
  – Detailed real-time note taking very important - or recording possible?

Methodologies - Mixed

• Shekhar et al. (2018) investigated student resistance to active learning by combining student focus groups, classroom observations and instructor interviews with quantitative survey instruments.

Some words of warning!
Many studies include student self-report data. Can be valuable but must be used in context. Questions such as “Do you feel this instruction was effective?” can be problematic.
Student Self Report Data

• Biases
  – May be giving social acceptable responses
  – Requires a shared understanding of question
  – Often has low response rate
  – Reinforcing social biases
    • gender (Mitchell and Martin 2018),
    • ethnicity (Fanid et al. 2019)
    • presence of cookies (Hessler et al. 2018).


Many studies report student grades in their analysis:

- Can you prove this is a robust ‘research’ method?
  - Can you show different years are comparable and therefore longitudinal tests are valid?
  - Can you show they are testing what you claim?
- What are the data use policies? Have students consented?
Where to Publish
Landscape of Engineering Education Research - Conferences

- SoTL conferences (ISSOTL, SOTL Commons)
- ASEE Regional conference
- ASEE/IEEE Frontiers in Education Conference
- IEEE Regional Conferences – EDUCON/TALE/EDUNINE
- ASEE Annual Conference and Exposition
- SEFI Annual Conference
- SASEE Annual Meeting
- Research in Engineering Education Symposia (REES)
- Education tracks at annual disciplinary conferences
  - Annual Fall Meeting of the Materials Research Society
  - Annual Meeting of the American Institute of Chemical Engineers
  - Biomedical Engineering Society Annual Fall Meeting
A helpful list can be found at: www.reen.co/eer-journals
Advances in Engineering Education (online) - advances.asee.org/
International Journal of Engineering Education www.ijee.ie/
Journal of STEM Education Innovations and Research www.auburn.edu/research/litee/jstem/
Landscape of Engineering Education Research - Discipline Specific

Chemical Engineering Education [Link]

[Images of journal covers and IEEE Education Society logo]
Landscape of Engineering Education Research - Learning Technologies