Basic research skills: Old problems and new methods

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Much interest in education but little usable knowledge

- Example:
- Need to review reading research on Arabic, particularly theses and dissertations
- Limited knowledge even on how to define the issues that should be sought
- Graduates as well as professors
Much demand for robust educational research but student supply is not usable

- Limited understanding of hypothesis testing
  - Implicit hypotheses made and not tested
  - Students often test the wrong concepts and find invalid answers.
- Limited mathematical and statistical preparation needed to handle research designs.
- Few available methods students can use to answer educational questions.
  - Dissertations often descriptive, “ethnography”
- No coursework to support better options

What problems should graduate-level “education specialists” be able to solve?

What is missing from their education?
Confusion between personal beliefs and research hypotheses

- If you teach students letters, they will be bored
- No one learns certain info unless they are interested in it
- Constructivist classrooms are the best. Students:
  - Must work in groups (social learning?!)  
  - Must not be tested often  
  - Must feel happy in school  
  - Must express themselves freely  
  - Must have high self-esteem
- Implicit: then they perform best

- How do we know???
- None of the above are questioned

Difficulties in establishing causality

- What logic is used to explain effects or lack thereof?
- Piaget, Vigotsky, Montessori, John Dewey

**Cognitive psychology is to education what biology is to medicine**

If you go to a hospital you expect doctors to know basic biology

Do educators know basics about memory functions?

Or research on motivation and emotions?
Education faculties do not teach how people learn

- Learning is used as a commonsense word
- No rules, research on memory are typically evoked
- Total ignorance about the practicalities of working memory
- How many courses does your department teach in cognitive science?
- Information processing:
  - Explains, predicts, & controls educational effects
  - Focuses attention on cognitive networks, working memory
- Other psychological research informs about student motivation, beliefs, social learning

Students have limited knowledge of the relevant research

- Education dissertations often limit research review to education theories and journals
- Students do not know the vast amounts of experimental research in psychology
- If they knew, they would write better informed dissertations and theses
Faculty sometimes lack sufficient knowledge or rigor

- A US student writing about the achievements of a certain educator:
- “He is the most famous educator in the world”
- Professor:
- “Aren’t you exaggerating a bit?”
- Instead, what should the professor answer?
  - ask the student to do?

Issue: Students may know little math, hard to teach statistics

- Dissertations have ethnography
- Qualitative analyses
  - Discourse analysis etc.
- Students collect data through questionnaires rather than experiments
  - Often survey methodology unknown
- Little if any data analyses
Practical vs. statistical significance distinction needed

- Would you recommend these methods to the relevant governments?
- A reading method applied in Kenya led to:
  - 40% of students scoring above 50%
  - Vs. control of 32% students scoring above 50%
- A reading method in Mali raised words per min. From 0.75 to 3
- Triumph! Statistical significance!
  - But 50% is very limited reading!
  - We need 45-60 wpm to make sense, not 3!

Experimental and quasi-experimental designs for research and evaluation

- Often statements about the above are general
- Big words and little knowledge on evaluation
The One Shot Case Study

- A single group studied only once

- Does it establish a cause-effect relationship?
- Internal validity issues?

One Group Pre-Posttest Design (no random assignment)

- $O_1 \times O_2$

- Does it establish a cause-effect relationship?
- Internal validity issues?
The Static Group Comparison (no random assignment)

- Does it establish a cause-effect relationship?
- Internal validity issues?

The Pretest-Posttest Control Group Design

- (diff in diff)
- \( \text{RO}_1 \times O_2 \)
- \( \text{RO}_3 \times O_4 \)

- Does it establish a cause-effect relationship?
- Internal validity issues?
The Solomon Four-Group Design

For the testing threat of internal validity

- Does it establish a cause-effect relationship?
- Internal validity issues?

The Posttest-Only Control Group Design

- Does it establish a cause-effect relationship?
- Internal validity issues?
More complex designs

\[ R \ O_1 \times \ O_2 \rightarrow \ O_3 \]
Start and end treatment

\[ R \ O_1 \times \ O_2 \]
\[ R \ O_1 \times \ O_2 \]
\[ R \ O_1 \times \ O_2 \]
Stack treatment
Regression discontinuity
etc.

Students need a much better statistical sense

- No good sense of variance
  - Prediction that "the students will do x.." is there no variability??

- Currently ritualistic recital of alpha and beta error, p values, confidence intervals
- Currently ritualistic null hypothesis
- Women unfortunately have less training
  - Less interest
  - More difficulty getting jobs
One solution: Dancing statistics!

- Dancing statistics on Youtube
- E.g.
- http://www.youtube.com/watch?v=orLSv0g9-Ik

Dancing statistics!

ESC software etc
Meaningful training needed in data analysis and interpretation

- Students may run SPSS, SAS, stata
- Don’t understand why certain procedures
- Don’t understand outcomes
- For qualitative analysis learn e.g. Atlas
  - Teaches rigor in specifications, categorization
- Students should have relevant courses
  - Aside from statistical basics

What new methods can students use in dissertations?

Strictly educational methods have reached their limits
It is now feasible to measure neurocognitive variables

- Potential questions to answer:
  - How to speed up reading and math?
  - How to develop textbooks that are read and understood most easily?
    - Event-related potentials routinely used
    - Eye trackers
    - Psychophysics displays
  - Costs involved, trainers needed

Eye tracker unit and processor
University of Rome

M. Martelli, G. Zoccolotti
Eye tracker monitors where the eyes move. Screen shows where they rested on a page.

Eye movements as a function of word length between a proficient and dyslexic reader.

G. Zoccolotti, U. of Rome
Event-related potentials monitor voltage in brain areas known to be related to reading proficiency.

Specialized Electroencephalogram Event-Related potentials (ERPs)
Relatively inexpensive research tool for monitoring reading acquisition
Brain imaging techniques
functional magnetic resonance imaging (fMRI)

Example:
Brain activation patterns of literates and illiterates

Some recommendations

- New coursework needed
  - Updated educational psychology, 2-3 courses
  - Including memory, social, perception, neuroscience
  - Popularizing cognitive psychology
  - New and attractive statistics courses
- Rigorous training in research designs
  - Specific focus on implicit hypothesis formation
- Training in critical thinking?
  - Some effects for law students
How to make these new courses more comprehensible, applicable?

PURPOSING MEMORY FUNCTIONS

Information processing theory

Information processing theory: knowledge travels from the senses to a sensory buffer; if it gets attention, it moves on to working memory which has very limited capacity. Surviving items get attached to cognitive networks that are in long-term memory. Knowledge from there travels back to working memory to be used in decisions as needed.
functions

Attention!

Cognitive networks

Long-term memory

Working memory

Around 12 seconds

About 7 items for simple text

Sensor register

An illustration of chunking
How big “chunks” do we start with?

**Phonics**
- Phonics: Single letters are small chunks

**Whole Words and Sentences**
- These are big chunks

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Cognitive networks

<table>
<thead>
<tr>
<th>Cognitive network: information items and multiple links</th>
<th>Looser net, less and less connected knowledge</th>
<th>Dense net, more and better connected knowledge</th>
</tr>
</thead>
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2/11/2013
What does it take for education faculty to get updated?

- Journal articles insufficient
- Cognitive science terminology too exotic
- Books like “how people learn” are too fuzzy
  - Must think hard how to apply neurocognitive research
- “Efficient learning for the poor”, Abadzi 2006
- Many research reviews
- Prepared 3 e-courses, currently in limbo
- Training needed for neuroimaging methods
  - E.g. A. Martinou center at Harvard U. in the US
- An international initiative needed?
- Lebanon has the intellectual power to do better

Thank you very much for your invitation!