Essential Skills in Computer-Enhanced Learning

Scholarship, Research, and the Questions We Should Be Asking

A framework for research in educational technology (ET)

Descriptive  Comparative  Qualitative

No intervention  Media-comparative  CAI-CAI

“Studies comparing computer with more conventional instruction or media should be discouraged.”
– Richard Clark - 1985

What’s wrong with media-comparative research?

CONFOUNDING

- Instr. methods
- Content
- Time
- Multimedia
- Adapt

Equalize artificial

What to do?
Comparative ET research

• Within-media comparisons
  • WBL-WBL
  • VP-VP
  • Simulator-simulator
• Controllable (minimize confounding)
• Help us know how to use, improve the new technology (clarify [Cook 2008])
• Advance the science (theory → predict)

What is the evidence?

A summary of systematic reviews

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No intervention & Media-comparative

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Outcome</th>
<th>No. of Interventions</th>
<th>Favors</th>
<th>Pooled effect size (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No intervention</td>
<td>Knowledge</td>
<td>126</td>
<td>Internet</td>
<td>1.00 (0.90, 1.10)</td>
</tr>
<tr>
<td></td>
<td>Skills</td>
<td>16</td>
<td>Internet</td>
<td>0.85 (0.49, 1.2)</td>
</tr>
<tr>
<td></td>
<td>Behavior</td>
<td>32</td>
<td>Internet</td>
<td>0.82 (0.63, 1.02)</td>
</tr>
</tbody>
</table>

Non-Internet comparison

| Satisfaction | 43 | 0.10 (-0.12, 0.32) |
| Knowledge | 63 | 0.12 (0.00, 0.24) |
| Skills | 12 | 0.09 (-0.26, 0.44) |
| Behavior | 6 | 0.51 (-0.24, 1.25) |

Pooled effect size (95% confidence interval)

How big?

CAI-CAI: Learning outcomes

<table>
<thead>
<tr>
<th>Research Theme</th>
<th>No. of Studies</th>
<th>Favors</th>
<th>Pooled Effect Size (95% CI), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online discussion</td>
<td>3</td>
<td>Internet</td>
<td>0.30 (-0.62, 1.13), p=0.57</td>
</tr>
<tr>
<td>Interactivity (theme)</td>
<td>15</td>
<td>Internet</td>
<td>0.27 (0.08, 0.46), p=0.006</td>
</tr>
<tr>
<td>Interactivity (coded)</td>
<td>21</td>
<td>Internet</td>
<td>0.53 (0.33, 0.73), p=0.001</td>
</tr>
<tr>
<td>Practice exercises (coded)</td>
<td>10</td>
<td>Internet</td>
<td>0.40 (0.08, 0.71), p=0.01</td>
</tr>
<tr>
<td>Feedback</td>
<td>2</td>
<td>Internet</td>
<td>0.68 (0.01, 1.35), p=0.047</td>
</tr>
<tr>
<td>Audio in tutorial</td>
<td>2</td>
<td>Internet</td>
<td>1.26 (-0.36, 2.85), p=0.13</td>
</tr>
<tr>
<td>Games and simulation</td>
<td>3</td>
<td>Internet</td>
<td>0.07 (-0.55, 0.68), p=0.83</td>
</tr>
<tr>
<td>Repetition</td>
<td>2</td>
<td>Internet</td>
<td>0.19 (0.09, 0.30), p=0.001</td>
</tr>
<tr>
<td>Synthesized information</td>
<td>3</td>
<td>Internet</td>
<td>1.09 (-0.20, 2.36), p=0.10</td>
</tr>
</tbody>
</table>

Pooled Effect Size (95% Confidence Interval)

Time: Media-comparative

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Comparison</th>
<th>Non-Internet</th>
<th>Internet</th>
<th>Effect size (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell (2007)</td>
<td>P</td>
<td>-0.53 (-0.65, -0.21)</td>
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</tr>
<tr>
<td>Grundman (2000)</td>
<td>P</td>
<td>0.52 (0.32, 0.72)</td>
<td></td>
<td></td>
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<tr>
<td>Spickard (2002)</td>
<td>F</td>
<td>-0.70 (-1.11, -0.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dennis (2003)</td>
<td>F</td>
<td>1.22 (0.40, 1.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leong (2003)</td>
<td>P</td>
<td>0.26 (-0.30, 0.71)</td>
<td></td>
<td></td>
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<tr>
<td>Cook (2005)</td>
<td>P</td>
<td>-0.39 (-0.63, -0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fried (2006, 81:1760)</td>
<td>P</td>
<td>-0.61 (-0.97, -0.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fried (2006, 82:1760)</td>
<td>P</td>
<td>-0.23 (-0.58, 0.12)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pooled effect size (95% confidence interval)

Summary

- Comparisons with no intervention → LARGE gains
- Media-comparative studies → On average NO DIFFERENCE
- CAI-CAI: Improved outcomes with
  - Interactivity
  - Practice exercises
  - Repetition
  - Feedback

How does this apply to you?

Repeat for ...

- Virtual patients
- Animations
- Technology-enhanced simulation

If you teach them, they will learn
It doesn’t matter what modality
Evidence doesn’t tell us how to teach

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Research Paradigms

- Experiment
  - Example: RCT
  - Reductionist; how
- Quality improvement
  - Example: Build-Measure-Learn
  - Practical; implementation
- Qualitative
  - Example: grounded theory
  - Why, when

Implementation

Build
- Minimal viable product
Learn
- Pivot or persevere
Measure
- Actionable metrics

Web vs lecture
Tutorial vs discussion board
Mastery learning vs routine

Synthesized vs recorded speech

- Systematic variation (one at a time) will refine instructional design
- Comparisons must be made within not between levels or will be confounded

When, Why

Scholarship: quality & questions

- New knowledge
- Original research

- New insights
- Synthesis
- Context
- Connections across disciplines

Discovery
Integration
Application
Teaching

- New ways to facilitate learning
- Instruct, method, curric, design, assessment
- Evid. based topic & method
- New applications
- Bridge theory and practice

Boyer EL. Scholarship Reconsidered. 1990
Standards for Assessing the Quality of Scholarship

- Clear goals
- Adequate preparation
- Appropriate methods
- Outstanding results
- Effective communication
- Reflective critique

Glasick CE. Scholarship Assessed. 1997

Important Questions in Technology-Enhanced Medical Education

- What is it? – Description
- Does it work? – Justification
- How or why does it work?
- When does it work?
- How can it be improved? – Clarification

Cook, Bordage, Schmidt, 2008

“What’s next?”

(Kevin Eva, 2008)

Scholarship: Questions & Quality

What are the questions regarding Educational Technologies you see being asked and answered during sessions?

What is the quality of scholarship?

Scholarship in Medical Education Technology

<table>
<thead>
<tr>
<th>Scholarship</th>
<th>Description</th>
<th>Justification</th>
<th>Clarification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Clear goals, adequate preparation, appropriate methods, outstanding results, effective communication, reflective critique