Establishing the Direction of Effect in Meta-Analyses with Multiple Treatments (and no obvious control)

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• Generic MA research question for comparative studies
• Case 1: Distance Education – Classroom Instruction (Bernard et al., 2004)
• Case 2: Beyond DE – F2F comparison (Bernard et al., 2009)
Project 1: 2000 – 2004

- **Question:** How does distance education compare to classroom instruction? (inclusive dates 1985-2002)
- **Total number of studies:** \( K = 232 \)
- **Measures:** Achievement, Attitudes and Retention (opposite of drop-out)
- **Divided into** Asynchronous and Synchronous DE


Summary of results: Achievement

<table>
<thead>
<tr>
<th>Achievement Outcomes</th>
<th>Type of DE</th>
<th>k</th>
<th>g+</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Combined</td>
<td>318*</td>
<td>0.013*</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Synchronous</td>
<td>92</td>
<td>-0.102*</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Asynchronous</td>
<td>174</td>
<td>0.053*</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

*Significantly heterogeneous average effect
# Summary of results: Attitudes

## Attitude Outcomes

<table>
<thead>
<tr>
<th>Type of DE</th>
<th>k</th>
<th>g+</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined</td>
<td>154</td>
<td>-0.081*</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Synchronous</td>
<td>83</td>
<td>-0.185*</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>71</td>
<td>-0.034*</td>
<td>&gt; 0.05</td>
</tr>
</tbody>
</table>

*Significantly heterogeneous average effect

# Summary of results: Retention

## Retention Outcomes

<table>
<thead>
<tr>
<th>Type of DE</th>
<th>k</th>
<th>g+</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined</td>
<td>103</td>
<td>-0.057*</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Synchronous</td>
<td>17</td>
<td>0.005</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>53</td>
<td>-0.093*</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

*Significantly heterogeneous effect sizes
Primary findings

- DE and CI are essentially equal ($g^+ \approx 0.0$ to low average effect) on all measures
- Effect size distributions are heterogeneous; some DE >> CI, some DE << CI
- Generally poor methodological quality
- Pedagogical study features account for more variation than media study features (Clark, 1994)
- Interactive DE an important variable*


Beyond DE & F2F comparison

Bernard et al. (2009)
Andersen (2003)
Beyond the Obvious: DE vs. DE

• What aspects of instructional approaches, technology applications, etc. make a difference in learner success* when DE studies are compared to DE studies?

*DE success is defined in terms of achievement gains, better attitudes and satisfaction and retention in courses.

DE vs. DE: Special Problem

• In most meta-analyses, the +/- valence of the effect size derives from the “control mean” subtracted from the “treatment mean”

• When there are two instructional treatments, which is the “control” and which is the “treatment”?
Examples

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Science undergraduate students - Research Methods</strong></td>
<td><strong>Physician Assistant students Medical Terminology</strong></td>
</tr>
<tr>
<td><strong>Group 1</strong></td>
<td><strong>Group 2</strong></td>
</tr>
<tr>
<td>Seven satellite TV tutorials (synchronous two-way audio and one-way video)</td>
<td>Three satellite TV tutorials and four (asynchronous) videotape cassettes to be viewed at their convenience.</td>
</tr>
</tbody>
</table>

DE-DE solution

- Address the studies frome a theoretical perspective
- Theoretical frameworks considered (Moore and Kearsley, 2005) : learner interaction, learner autonomy, and technological functionality.
Dimension 1: Learner interactivity

a) Student-Student Interaction
b) Student-Teacher Interaction
c) Student-Content Interaction

Dimension 2: Learner Autonomy

a) Logistical flexibility
b) Pedagogical Flexibility
Dimension 3: Technological Functionality

a) Immediacy of communication
b) Cognitive and support tools
c) Information and knowledge accessibility

Overall Framework

- Learner interactivity (non-orthogonal)
  - Student-Student Interaction
  - Student-Teacher Interaction
  - Student-Content Interaction
- Learner autonomy (non-orthogonal)
  - Logistical flexibility
  - Pedagogical Flexibility
- Technological functionality or enabling technology (non-orthogonal)
  - Immediacy of communication
  - Cognitive and support tools
  - Information and knowledge accessibility
**Framework Applied**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interactivity</strong></td>
<td>Exp S/T</td>
<td>Control S/T</td>
</tr>
<tr>
<td><strong>Autonomy</strong></td>
<td>Control Logistic</td>
<td>Exp Logistic</td>
</tr>
<tr>
<td><strong>Functionality</strong></td>
<td>Exp Immediacy</td>
<td>Control Immediacy</td>
</tr>
</tbody>
</table>

**Selected theoretical framework**

**Question:** What are the effects of three types of interaction in DE vs. DE studies? (Inclusive dates 1985 to 2006)

**Two definitions of interaction:**

- Interaction should refer “in a restrictive manner to cover only those activities where the student is in two-way contact with another person (or persons)” (Daniel & Marquis, 1988, p. 339)
- Interactions are “reciprocal events that require at least two objects and two actions. Interactions occur when these objects and actions mutually influence one another” (Wagner, 1994, p. 8)
Selected theoretical framework

Moore (1989) distinctions are:

- Three types of interaction
  - Student-student interaction
  - Student-teacher interaction
  - Student-content interaction

Anderson (2003) hypotheses state:

- Deep, meaningful learning is produced from at least one out of 3 interactions at a high level (achievements)
- High levels of more than 1 out of 3 interactions will produce satisfying educational experience (attitudes)

Procedure

- Sorted 74 achievement and 44 attitude effects into SS, ST and SC categories
- Two judges determined which condition was the “best type” for each category; that group became the treatment and the other the control
- Three rounds of coding
Do the three types of interaction differ? Moore’s distinctions

Achievement Outcomes

<table>
<thead>
<tr>
<th>Interaction Categories</th>
<th>Achievement</th>
<th>k</th>
<th>( g^*_{adj} )</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-Student</td>
<td></td>
<td>10</td>
<td>0.49</td>
<td>0.08</td>
</tr>
<tr>
<td>Student-Teacher</td>
<td></td>
<td>44</td>
<td>0.32</td>
<td>0.04</td>
</tr>
<tr>
<td>Student-Content</td>
<td></td>
<td>20</td>
<td>0.46</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>74</td>
<td>0.38</td>
<td>0.03</td>
</tr>
<tr>
<td>Between-class</td>
<td></td>
<td></td>
<td>7.05*</td>
<td></td>
</tr>
</tbody>
</table>

Moore’s distinctions seem to apply for achievement (equal importance)

Investigating “treatment strength”

- Anderson’s hypotheses involve improving the ‘strength’ of interaction treatments
- We defined treatment strength as ratings of difference between two conditions

Coded strength as:
- 0) conditions are almost equal
- 1) treatment is > control
- 2) treatment is >> control
**Does strengthening interaction improve achievement? Anderson’s hypothesis**

### Achievement Outcomes

<table>
<thead>
<tr>
<th>Interaction Strength</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k</td>
</tr>
<tr>
<td>Low Strength</td>
<td>31</td>
</tr>
<tr>
<td>Med Strength</td>
<td>28</td>
</tr>
<tr>
<td>High Strength</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>74</td>
</tr>
<tr>
<td><strong>(Q) Between-class</strong></td>
<td></td>
</tr>
</tbody>
</table>

Anderson’s hypothesis about achievement appears to be supported.

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**Do interaction combinations differ?**

### Achievement Outcomes

<table>
<thead>
<tr>
<th>Levels of Treatment</th>
<th>SS + SC</th>
<th>ST + SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength</td>
<td>k</td>
<td>SE</td>
</tr>
<tr>
<td>Equal (0)</td>
<td>11</td>
<td>0.17</td>
</tr>
<tr>
<td>Low (1)</td>
<td>34</td>
<td>0.33</td>
</tr>
<tr>
<td>Medium (2)</td>
<td>29</td>
<td>0.48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>74</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>(Q) Between-class</strong></td>
<td></td>
<td>12.40**</td>
</tr>
</tbody>
</table>
What have we learned about the effects of interaction on achievement?

- The presence of any type of interaction enhances achievement outcomes
- Increasing cognitive engagement (i.e., providing the conditions for interaction to occur) improves achievement (i.e., learning)
- This is especially true for student-content interaction and any combination that involves student-content interaction
- The approach of selecting most relevant theoretical framework for dealing with multiple treatment conditions deserves further exploration

Research Team

- Bob Bernard (Principal Investigator)
- Phil Abrami (Co-investigator)
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- Mike Surkes (Research Assistant)
- Edward Bethel (Research Assistant)
- Cristina Galofre (Research Assistant)
- Kamran Shaikh (Research Assistant)
- Anna Peretiatkovitz, Rui Miao, Manon Lamontagne, Julia Barkhouse, Katherine Hanz, & Anna Sokolovskaya (Library Assistants)

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References


