



## 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)

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## Project 1: 2000 – 2004

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- **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**

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Wallet, P.A., Fiset, M., & Huang, B. (2004). How does distance education compare to classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research*, 74(3), 379-439.

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## Summary of results: Achievement

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### Achievement Outcomes

Type of DE	k	g+	Sig.
Combined	318*	0.013*	> 0.05
Synchronous	92	-0.102*	< 0.05
Asynchronous	174	0.053*	< 0.05

\*Significantly heterogeneous average effect

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## Summary of results: Attitudes

### Attitude Outcomes

Type of DE	k	g+	Sig.
Combined	154	-0.081*	< 0.05
Synchronous	83	-0.185*	< 0.05
Asynchronous	71	-0.034*	> 0.05

\*Significantly heterogeneous average effect

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## Summary of results: Retention

### Retention Outcomes

Type of DE	k	g+	Sig.
Combined	103	-0.057*	< 0.05
Synchronous	17	0.005	> 0.05
Asynchronous	53	-0.093*	< 0.05

\*Significantly heterogeneous effect sizes

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## Primary findings

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

\*Lou, Y., Bernard, R.M., & Abrami, P.C. (2006). Media and pedagogy in undergraduate distance education: A theory-based meta-analysis of empirical literature. *Educational Technology Research & Development*, 54(2), 141-176.

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## Beyond DE & F2F comparison

Bernard et al. (2009)

Andersen (2003)

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## Beyond the Obvious: DE vs. DE

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- 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.

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## DE vs. DE: Special Problem

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- 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”?

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## Examples

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<b>Beyth-Marom and Saporta (2002)</b>		<b>Bell, Hudson and Heinan (2004)</b>	
<b>Social Science undergraduate students - Research Methods</b>		<b>Physician Assistant students Medical Terminology</b>	
<b>Group 1</b>	<b>Group 2</b>	<b>Group 1</b>	<b>Group 2</b>
Seven satellite TV tutorials (synchronous two-way audio and one-way video)	Three satellite TV tutorials and four (asynchronous) videotape cassettes to be viewed at their convenience.	Case studies with online asynchronous conference discussions	Students worked independently on the web to solve case studies

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## DE-DE solution

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

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## Dimension 1: Learner interactivity

- a) Student-Student Interaction
  - b) Student-Teacher Interaction
  - c) Student-Content Interaction
- } Orthogonal Dimensions

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## Dimension 2: Learner Autonomy

- a) Logistical flexibility
  - b) Pedagogical Flexibility
- } Orthogonal Dimensions

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## Dimension 3: Technological Functionality

- a) Immediacy of communication
  - b) Cognitive and support tools
  - c) Information and knowledge accessibility
- } Orthogonal Dimensions

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## 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
- Orthogonal Dimensions
- Orthogonal Dimensions
- Orthogonal Dimensions

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## Framework Applied

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	Beyth-Marom and Saporta (2002)		Bell, Hudson and Heinan (2004)	
	7 satellite TV tutorials	3 TV tutorials 4 videotapes	Individual case-studies	Collaborative case-studies
<b>Interactivity</b>	Exp S/T	Control S/T	Control S/S	Exp S/S
<b>Autonomy</b>	Control Logistic	Exp Logistic	Exp Logistic	Control Logistic
<b>Functionality</b>	Exp Immediacy	Control Immediacy	NA	NA

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## Selected theoretical framework

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**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)

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## Selected theoretical framework

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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)

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## Procedure

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- 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

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## Do the three types of interaction differ? Moore's distinctions

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### Achievement Outcomes

Interaction Categories	Achievement		
	k	g <sub>+adj.</sub>	SE
Student-Student	10	0.49	0.08
Student-Teacher	44	0.32	0.04
Student-Content	20	0.46	0.05
Total	74	0.38	0.03
Between-class		7.05*	

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

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## Investigating "treatment strength"

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- 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

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## Does strengthening interaction improve achievement? Anderson's hypothesis

### Achievement Outcomes

Interaction Strength	Achievement		
	k	$g_{adj.}$	SE
Low Strength	31	0.25	0.04
Med Strength	28	0.55	0.05
High Strength	15	0.36	0.06
Total	74	0.38	0.03
(Q) Between-class		23.80**	

Anderson's hypothesis about achievement appears to be supported

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## Do interaction combinations differ?

### Achievement Outcomes

Levels of Treatment Strength	SS + SC		ST + SC	
	k	$g_{adj.}$	k	$g_{adj.}$
Equal (0)	11	0.17	4	0.40
Low (1)	34	0.33	32	0.28
Medium (2)	29	0.48	38	0.49
Total	74	0.38	74	0.38
(Q) Between-class		12.40**		13.94**

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## What have we learned about the effects of interaction on achievement?

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- 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

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## Research Team

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- Bob Bernard (Principal Investigator)
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