Assessing Learning with Technology: What the Research Says

Dr. Mike Rapatan
DLSU-Manila
PEMEA
Aug. 23, 2017

MODES OF TEACHING AND LEARNING

Which of these innovations is the most effective?
How do these compare with F2F?
What does research say?

AUTHORS	INDEPENDENT VARIABLE	DEPENDENT VARIABLE
1991: ***Kulik & Kulik****	**COMPUTER TECHNOLOGY**	**LEARNER ACHIEVEMENT**
2000: ***Roschelle et al.***	**COMPUTER TECHNOLOGY**	**LEARNER ACHIEVEMENT**
2000: ***National Assessment of Educational Progress***	**SOFTWARE DESIGN**	**LEARNER ACHIEVEMENT**
2002: ***Thompson***	**BLENDED LEARNING**	**PERFORMANCE ON REAL WORLD TASKS AND TIMING PERFORMANCE**
2003: ***Waxman et al.****	**COMPUTER TECHNOLOGY**	**-LEARNER ACHIEVEMENT** **-LEARNER MOTIVATION**
2006: ***Zhao et al. ****	**DISTANCE LEARNING**	**LEARNER ACHIEVEMENT**
2011: ***Tamim et al.***	**COMPUTER TECHNOLOGY**	**LEARNER ACHIEVEMENT**
2013: ***Means et al. ****	**BLENDED LEARNING**	**LEARNER ACHIEVEMENT**
2014: ***Colvin et al.***	**MOOCs**	**LEARNER ACHIEVEMENT**
2015: ***Sung et al. ****	**LAPTOPS AND OTHER MOBILE DEVICES**	**LEARNER ACHIEVEMENT**

***meta-analysis**

"Meta-analysis is *better suited to answering questions about whether to consider implementing online learning* or *what features to look for in judging online learning products* than to guiding the myriad of decisions involved in actually designing and implementing online learning…"

-Means et al., 2013

Period covered by selected studies: 1991-2015

Types: CBI to mobile learning

- Studies used a controlled design (experimental or quasi-experimental)

-Design studies, exploratory studies, or case studies that did not use a controlled research design were excluded

-For quasi-experimental designs, the analysis of the effects of the intervention had to include statistical controls for possible differences between the treatment and control groups in terms of prior achievement.

Possible confounding variables:

-more instructional time

-more and varied learning resources

-varied interactions with hyperlinks and with peers

1991: 254 STUDIES; K-12 AND ADULT

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Effectiveness of Computer-Based Instruction: An Updated Analysis

Chen-Lin C. Kulik and James A. Kulik

Center for Research on Learning and Teaching
The University of Michigan

Abstract — *A meta-analysis*
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positive effects on students. Th
from kindergarten pupils to ad
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computer-based instruction (CBI) to drill, tutor, and test students and to manage instructional programs. In recent years these CBI programs have been used increasingly in schools to supplement or replace more conventional teaching methods. Many educational technologists believe that CBI will not only reduce educa-

"CBI programs ***raised student examination scores by 0.30 standard deviations in the average study, a moderate but significant effect.*** Size of effect varied, however, as a function of study feature…"

1991: 254 STUDIES; K-12 AND ADULT

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positive effects on students. The studies covered learners
from kindergarten pupils to adult students. CBI progr
examination scores by 0.30 standard deviations in th
moderate but significant effect. Size of effect varied, ho
of study feature. Effects were larger in published rathe
studies, in studies in which different teachers taught exper
classes, and in studies of short duration. CBI also p
positive changes in student attitudes toward teaching an
reduced substantially the amount of time needed for instru

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computer-based instruction (CBI) to drill, tutor, and test s
instructional programs. In recent years these CBI programs have been used increasingly in schools to supplement or replace more conventional teaching methods. Many educational technologists believe that CBI will not only reduce educa-

Moderator variables:
-publication in journals
-duration of 4 weeks or less
-different instructors in experimental and control classes

2000:
21 STUDIES;
K-12

Changing How and What Children Learn in School with Computer-Based Technologies

Jeremy M. Roschelle, Roy D. Pea, Christopher M. Hoadley, Douglas N. Gordin, Barbara M. Means

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Christopher M. Hoadley, Ph.D., is a research and computer scientist at the Center for Technology in Learning at SRI International, an inde-

Abstract

Schools today face ever-increasing demands in their attempts to ensure that students are well equipped to enter the workforce and navigate a complex world. Research indicates that computer technology can help support learning, and that it is especially useful in developing the higher-order skills of critical thinking, analysis, and scientific inquiry. But the mere presence of computers in the classroom does not ensure their effective use. Some computer applications have been shown to be more successful than others, and many factors influence how well even the most promising applications are implemented.

This article explores the various ways computer technology can be used to improve how and what children learn in the classroom. Several examples of computer-based applications are highlighted to illustrate ways technology can enhance how children learn by supporting four fundamental characteristics of learning: (1) active engagement, (2) participation in groups, (3) frequent interaction and feedback, and (4) connections to real-world contexts. Additional examples illustrate ways technology can expand what children learn by helping them to understand core concepts in subjects

2000: 21 STUDIES - K-12

This article explores the various ways computer technology can be used to improve how and what children learn in the classroom. Several examples of computer-based applications are highlighted to illustrate ways technology can enhance how children learn by supporting four fundamental characteristics of learning: (1) active engagement, (2) participation in groups, (3) frequent interaction and feedback, and (4) connections to real-world contexts. Additional examples illustrate ways technology can expand what children learn by helping them to understand core concepts in subjects like math, science, and literacy. Research indicates, however, that the use of technology as an effective learning tool is more likely to take place when embedded in a broader education reform movement that includes improvements in teacher training, curriculum, student assessment, and a school's capacity for change. To help inform decisions about the future role of computers in the classroom, the authors conclude that further research is needed to identify the uses that most effectively support learning and the conditions required for successful implementation.

2000: NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (N=15,000) K-12

Variable	Effect on test scores
Frequency of school computer use	-12**
Frequency of home computer use	.04**
Teacher computer preparedness	.02**
Use simulations	.07**
Use data analysis	.04**
Student socioeconomic status	.54**
Average class size	.09**
Teacher background	-.01**

*p<.10, **p<.05 N=15,000

Table 6. Links Between Technology Use and Science Scores – Eighth Graders

Variable	Effect on test scores
Frequency of school computer use	-.02
Frequency of home computer use	-.07**
Teacher computer preparedness	.01**
Use Reading	-.05**
Use Writing	.06**
Use Grammar/Punctuation	-.05**
Student socioeconomic status	.55**
Student reading background	18**

*p<.10, **p<.05 N=15,000

Table 7. Links Between Technology Use and Reading Scores – Eighth Graders

Variable	Effect on test scores
Frequency of school computer use	-.06**
Frequency of home computer use	.07**
Teacher computer preparedness	.05**
Use simulations/applications	.04**
Use drill and practice	-.06**
Student socioeconomic status	.39**
Average class size	.06**
Teacher background	.05**

*p<.10, **p<.05 N=15,000

Table 5. Links Between Technology Use and Math Scores – Eighth Graders

2003:
42 STUDIES;
K-12 classes

A Meta-Analysis of the Effectivenesss of Teaching and Learning With Technology on Student Outcomes

December 2003

Hersh C. Waxman
Meng-Fen Lin
Georgette M. Michko
University of Houston

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Learning Point Associates was founded as the North Central Regional Educational Laboratory (NCREL) in 1984. NCREL continues its research and development work as a wholly owned subsidiary of Learning Point Associates.

The mean of the study-weighted effect sizes averaging across all outcomes was *.410 ($p < .001$), with a 95-percent confidence interval* (CI) of .175 to .644. This result indicates that teaching and learning with technology has a *small, positive, significant ($p < .001$) effect on student outcomes* when compared to traditional instruction.

2003:
42 STUDIES;
K-12 classes

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"…the findings from the present meta-analysis revealed ***no significant differences across the contextual categories*** of study quality, teaching, and technology characteristics. In other words, the results can be ***generalized across a wide variety of conditions*** that have been investigated as well as across student, school, and study characteristics.

2005:
51 STUDIES;
HS - INDUSTRY

What Makes the Difference? A Practical Analysis of Research on the Effectiveness of Distance Education

YONG ZHAO
Michigan State University

JING LEI
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BO YAN
CHUN LAI
Michigan State University

HUEYSHAN SOPHIA TAN
Coastal South Carolina University

" Meta-analysis is a technique for combining the results of multiple experiments or quasi-experiments to obtain a composite estimate of the size of the effect. The result of each experiment is expressed as an effect size, which is the difference between the mean for the treatment group and the mean for the control group, divided by the pooled standard deviation. "

This article reports findings of a meta-analytical study of research on distance education. The purpose of this study was to identify factors that affect the effectiveness of distance education. The results show that although the aggregated data of available studies show no significant difference in outcomes between distance education and face-to-face education as previous research reviews suggest, there is remarkable difference across the studies. Further examination of the difference reveals that distance education programs, just like traditional education programs, vary a great deal in their outcomes, and the outcome of distance education is associated with a number of pedagogical and technological factors. This study led to some important data-driven suggestions for and about distance education.

2005:
51 STUDIES;
HS - INDUSTRY

The overall weighted mean effect size between distance education and face-to-face education was +0.10, with a 95% confidence interval of [-.01 .22] (z = 1.76, p > .05, SD = .06). This finding suggests that considered *as a whole, there is no significant difference between distance education and face-to-face education,* confirming the "no significant difference" claim of previous researchers.

2005:
51 STUDIES;
HS - INDUSTRY

“ However, a closer look at the data revealed considerable variation among the effect sizes: There is a wide range of effect sizes (from -1.43 to 1.48); about two thirds of the studies show that distance education produced better student outcomes than face-to-face education, whereas the remaining third showed just the opposite.”

2005:
51 STUDIES;
HS - INDUSTRY

"…distance education as a form of education is as good (or as bad) as face-to-face education… Thus it is *advisable not to automatically apply the 'no-significant-difference' label to all distance education programs* just because the positive findings of some studies cancel out the negative findings of other studies…"

2005:
51 STUDIES;
HS - INDUSTRY

Factors contributing to favorable outcomes with distance education:
-instructor involvement (medium to high)
-interaction with media (medium to high)
-types of interactions (synchronous + asynchronous)

2005:
51 STUDIES;
HS - INDUSTRY

"…Our findings suggest that *the presence of a 'live' instructor is important* for effective distance education… based on previous research, 'live' human instructors are still needed to ensure quality distance education.

2011:
25 STUDIES;
8-12 & POST-SECONDARY

What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study

Rana M. Tamim
Hamdan Bin Mohammed e-University

Robert M. Bernard, Eugene Borokhovski, Philip C. Abrami, and Richard F. Schmid
Concordia University

25 STUDIES

This research study employs a second-order meta-analysis procedu marize 40 years of research activity addressing the question, does technology use affect student achievement in formal face-to-face cl as compared to classrooms that do not use technology? A study-le analytic validation was also conducted for purposes of compar extensive literature search and a systematic review process result inclusion of 25 meta-analyses with minimal overlap in primary l encompassing 1,055 primary studies. The random effects mean eff 0.35 was significantly different from zero. The distribution was neous under the fixed effects model. To validate the second-order meta-analysis, 574 individual independent effect sizes were extracted from 13 out of the 25 meta-analyses. The mean effect size was 0.33 under the random effects model, and the distribution was heterogeneous. Insights about the state of the field, implications for technology use, and prospects for future research are discussed.

KEYWORDS: computers and learning, instructional technologies, achievement, meta-analysis.

The synthesis of the extracted effect sizes, with the support of the validation process, revealed a significant positive *small to moderate effect size favoring the utilization of technology* in the experimental condition over more traditional instruction (i.e., technology free) in the control group.

TABLE 2

Mixed effects comparison of levels of methodological quality

Level	*k*	*ES*	*SE*	*Q* statistic
Low	8	0.42*	0.07	
Medium	7	0.35*	0.04	
High	10	0.31*	0.03	
Total between				2.50†

†$p = .29$. *$p < .05$.

The average effect size in both the second-order meta-analysis and the validation study ranged between 0.30 and 0.35 for both the fixed effects and the random effects models, which is *low to moderate* in magnitude according to the qualitative standards suggested by J. Cohen (1988). Such an effect size magnitude indicates that the mean in the experimental condition will be at the 62nd percentile relative to the control group. In other words, the *average student in a classroom where technology is used will perform 12 percentile points higher* than the average student in the traditional setting that does not use technology to enhance the learning process.

THOMSON JOB IMPACT STUDY

THE NEXT GENERATION OF CORPORATE LEARNING

To determine if there are significant performance differences on real-world tasks among learners who received a Blended Learning solution, E-Learning alone, or no training.

To determine if there are significant time performance differences on real-world tasks among learners who received a Blended Learning solution, e-Learning alone, or no training on real-world tasks

February 2002

Instructional Delivery Setting	Teacher-Student Interaction	Teacher-Student Location
Face-to-face (F2F)	ALWAYS	SAME PLACE, SAME TIME
Distance Education/E-learning	MOST OF THE TIME, THERE IS LITTLE OR NONE	IN DIFFERENT PLACES AND TIMES
Blended Learning	AT CERTAIN TIMES, YES; AT CERTAIN TIMES, NO	IN BOTH THE SAME PLACE AND TIME AND IN DIFFERENT PLACES AND TIMES

Table 1. Comparison of Instructional Delivery Settings

Blended learning: *the appropriate mix and use of face-to-face instructional methods and various learning technologies to support planned learning and foster subsequent learning outcomes (Lim & Morris, 2009).*

- The group that received Blended Learning performed with **30% more accuracy** than the E-Learning alone group.
- The group that received Blended Learning performed real-world tasks **41% faster** than those who received E-Learning alone.
- The group that received Blended Learning performed tasks with **159% more accuracy** than the control group
- The E-Learning alone group performed tasks with **99% more accuracy** than the control group.

These findings demonstrate that this defined Blended Learning solution heightens the overall on-the-job performance achieved by e-Learning alone and that either form of training is much more effective than no training at all. ***Simply stated, this study shows that a structured Blended Learning model does result in greater workforce productivity.***

Other research measuring the impact of varied mixes of classroom and online instruction suggests that learners taking blended courses delivered in the context of the case method may perform better at multiple levels of learning outcomes versus traditional face-to-face instruction. Learners do as well in the traditional classroom, but data suggest the students in online environments may perform better at multiple levels of learning outcomes especially when using a blend of classroom and online technologies (Webb, 2005).

2013:
99 STUDIES;
8-12 & HIGHER ED
AND INDUSTRY

The Effectiveness of Online and Blended Learning: A Meta-Analysis of the Empirical Literature

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SRI International

YUKIE TOYAMA
SRI International

ROBERT MURPHY
SRI International

MARIANNE BAKI
SRI International

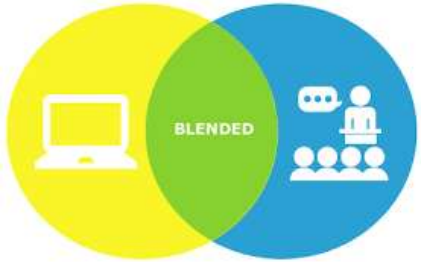
"The overall finding of the meta-analysis is that online learning (*the combination of studies of purely online and of blended learning) on average produces stronger student learning outcomes than learning solely through face-to-face instruction. The* mean effect size for all 50 contrasts was +0.20, p < .001."

2013:
99 STUDIES;
8-12 & HIGHER ED
AND INDUSTRY

Online Learning: Learning that takes place entirely or significantly over the Internet

Purely Online: Learning that takes place entirely over the Internet. In this study, cases in which all of the instruction on the content assessed by the outcome measure was delivered through the Internet were categorized as purely online learning.

Blended: Learning through a combination of online and face-to-face experiences. In this study, cases where students learned 25% or more but not all of the assessed content over the Internet were categorized as blended learning.



These activities were undertaken to address four research questions:

1. *How does the effectiveness of online learning compare with that of face-to-face instruction?*
2. *Does supplementing face-to-face instruction with online instruction enhance learning?*
3. *What practices are associated with more effective online learning?*
4. *What conditions influence the effectiveness of online learning?*

1. How does the effectiveness of online learning compare with that of face-to-face instruction?

The meta-analysis of 50 study effects, 43 of which were drawn from research with older learners, found that[2]

- *Students in online conditions performed modestly better, on average, than those learning the same material through traditional face-to-face instruction.* Learning outcomes for students who engaged in online learning exceeded those of students receiving face-to-face instruction, with an average effect size of +0.20 favoring online conditions.[3] The mean difference between online and face-to-face conditions across the 50 contrasts is statistically significant at the $p < .001$ level. Interpretations of this result, however, should take into consideration the fact that online and face-to-face conditions generally differed on multiple dimensions, including the amount of time that learners spent on task. The advantages observed for online learning conditions therefore may be the product of aspects of those treatment conditions other than the instructional delivery medium per se.

2. Does supplementing face-to-face instruction with online instruction enhance learning?

Instruction combining online and face-to-face elements had a larger advantage relative to purely face-to-face instruction than did purely online instruction. The mean effect size in studies comparing blended with face-to-face instruction was +0.35, $p < .001$. This effect size is larger than that for studies comparing purely online and purely face-to-face conditions, which had an average effect size of +0.05, $p = .46$. In fact, the learning outcomes for students in purely online conditions and those for students in purely face-to-face conditions were statistically equivalent. An important issue to keep in mind in reviewing these findings is that many studies did not attempt to equate (a) all the curriculum materials, (b) aspects of pedagogy and (c) learning time in the treatment and control conditions. Indeed, some authors asserted that it would be impossible to have done so. Hence, the observed advantage for blended learning conditions is not necessarily rooted in the media used per se and may reflect differences in content, pedagogy and learning time.

3. What moderator variables are associated with more effective online learning?

In terms of *PRACTICES*:
-Expository/Collaborative
-Asynchronous with instructor and peers
-Use of text with other media
-More time for online tasks than F2F
-Opportunities for face time with instructor and peers
-Opportunities for practice
-Feedback provided

3. What moderator variables are associated with more effective online learning?

Table 6. Tests of Conditions as Moderator Variables

Variable	Contrast	Number Studies	Weighted Effect Size	Standard Error	Lower Limit	Upper Limit	Q Statistic
Year Published	1997–2003	13	0.195	0.105	-0.010	0.400	0.00
	2004 or after	37	0.203***	0.058	0.088	0.317	
Learner Type	K–12 students	7	0.1664	0.118	-0.065	0.397	3.25
	Undergraduate	21	0.309***	0.083	0.147	0.471	
	Graduate student/Other	21	0.100	0.084	-0.064	0.264	
Subject Matter	Medical/ Health care	16	0.205*	0.090	0.028	0.382	0.00
	Other	34	0.199**	0.062	0.0770	0.320	

*$p < .05$. **$p < .01$. ***$p < .001$.

In terms of *CONDITIONS*:

NOT SIGNIFICANT MODERATOR VARIABLES:

-Year or publication (indicating type of technology used)

-Age of learners

-Subject area

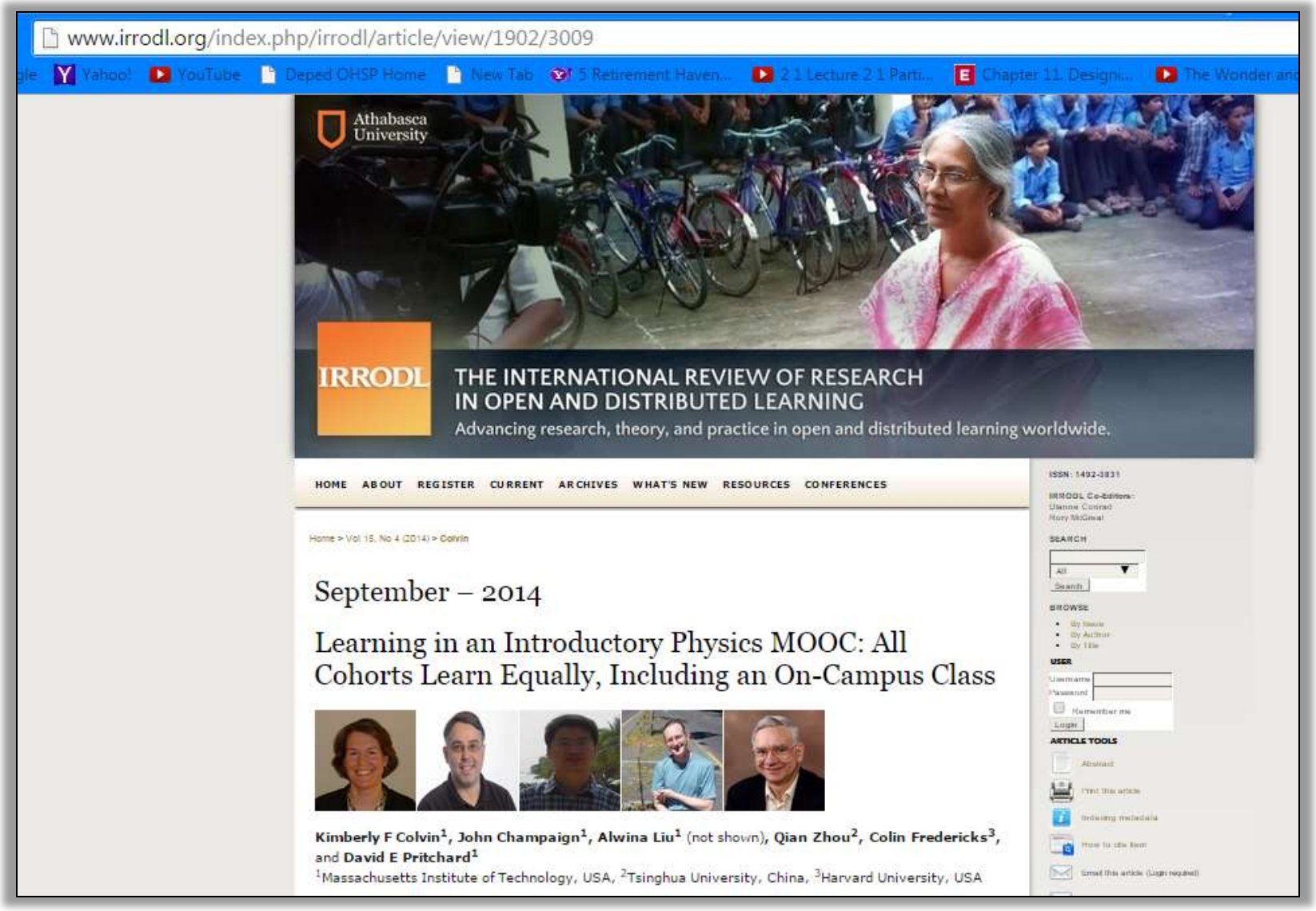
3. What moderator variables are associated with more effective online learning?

In terms of *STUDY METHODS*:
SIGNIFICANT MODERATOR VARIABLE:
-F2F instructional material identical to online material
NOT SIGNIFICANT MODERATOR VARIABLES:
-change in instructors in F2F and online classes
-type of knowledge tested (procedural, declarative or strategic)

4. What generalizations can we make about the effectiveness of online learning?

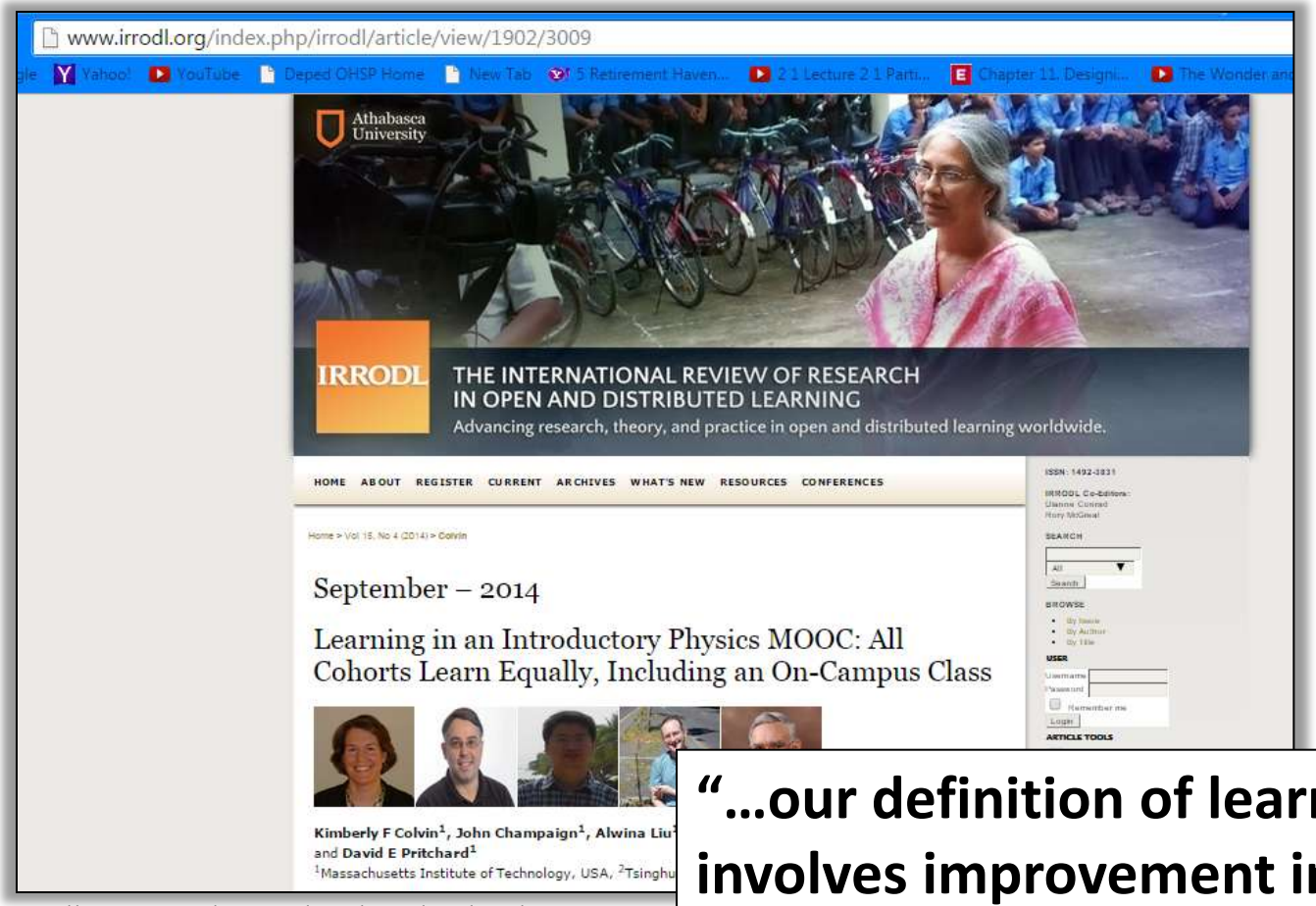
"The effectiveness of online learning approaches appears quite broad across different content and learner types.

Online learning appeared to be an effective option for both undergraduates (mean effect of +0.30, $p < .001$) and for graduate students and professionals (+0.10, $p < .05$) in a wide range of academic and professional studies."



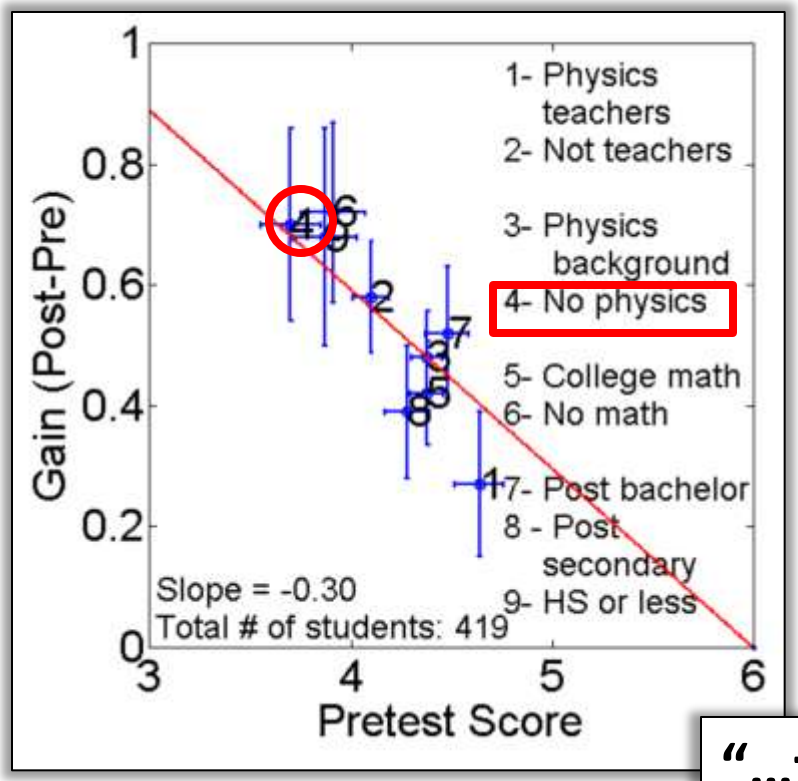
http://www.irrodl.org/index.php/irrodl/article/view/1902/3009

Hollands: "…the most rigorous attempt to date to measure learning in a MOOC…"



http://www.irrodl.org/index.php/irrodl/article/view/1902/3009

"…our definition of learning involves improvement in answering questions *with*, rather than *without*, outside assistance."



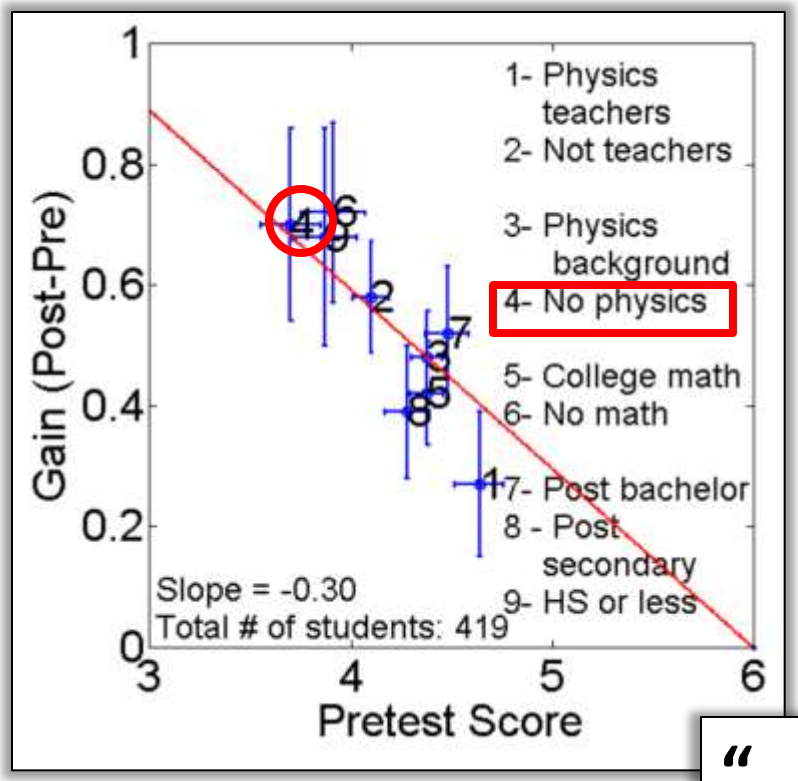
International Review of Research in Open and Distance Learning, in a paper by David Pritchard, MIT's Cecil and Ida Green

http://phys.org/news/2014-09-online-classes.html#jCp

MITx Mechanics Review

"…the normalized gain is typically 0.23 for traditionally taught courses, but increases to about 0.48 for interactively taught courses."

https://www.edx.org/blog/comparing-effectiveness-learning-moocs

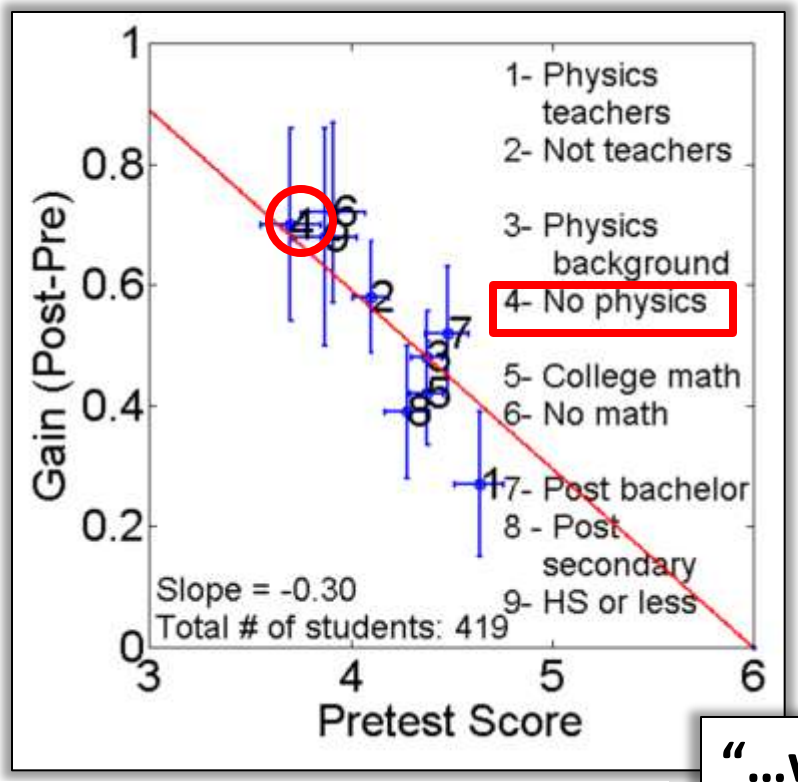


International Review of Research in Open and Distance Learning, in a paper by David Pritchard, MIT's Cecil and Ida Green
http://phys.org/news/2014-09-online-classes.html#jCp

MITx Mechanics Review

"…that our students learn conceptual topics slightly better than in a traditional, lecture-based, class."

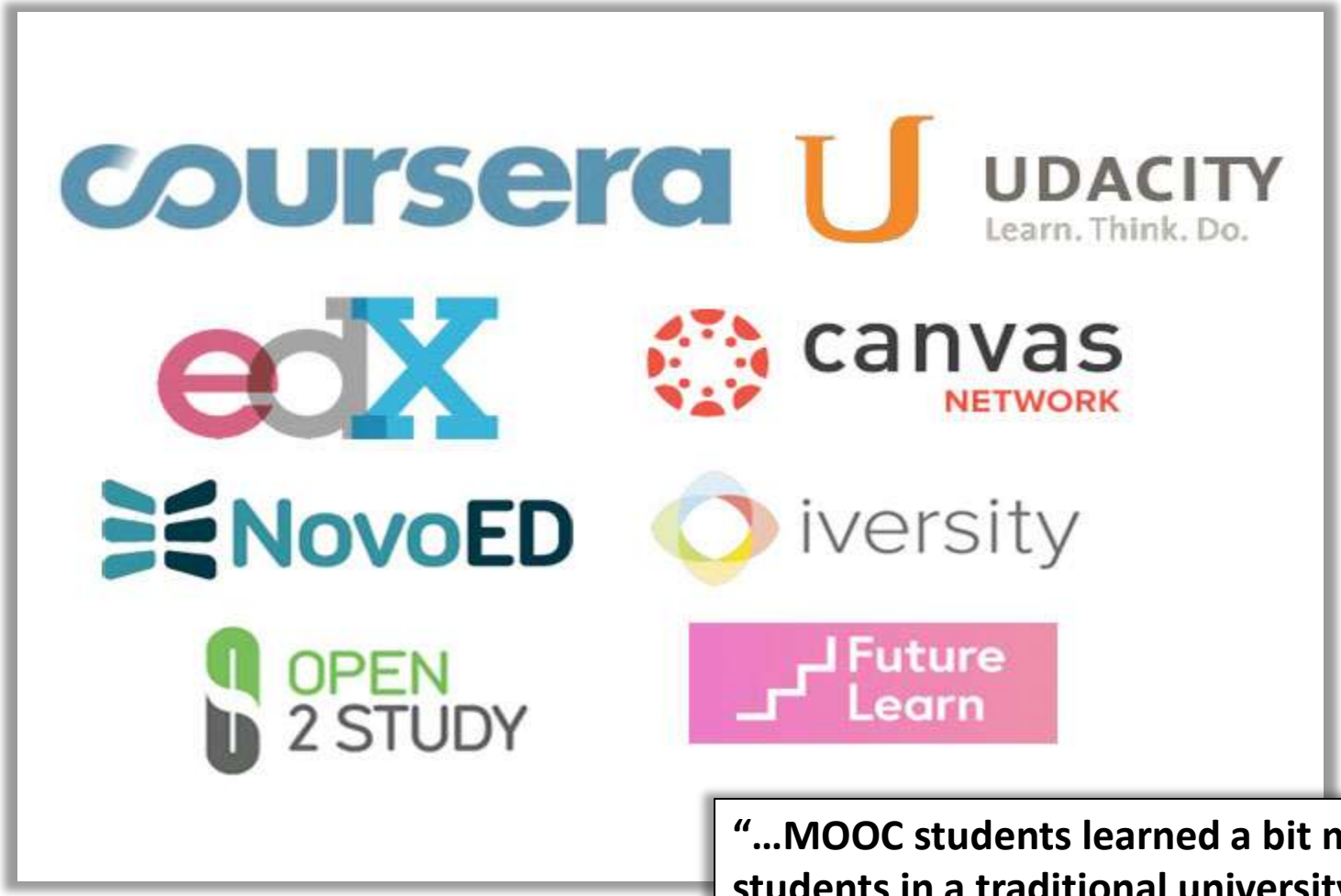
https://www.edx.org/blog/comparing-effectiveness-learning-moocs



International Review of Research in Open and Distance Learning, in a paper by David Pritchard, MIT's Cecil and Ida Green
http://phys.org/news/2014-09-online-classes.html#jCp

MITx Mechanics Review

"…we see no cohorts lying significantly below or above the normalized gain lines that fits all students in that sample. This certainly should allay concerns that less well prepared students cannot learn in MOOCs."



"…MOOC students learned a bit more than students in a traditional university course, but less than students taught with an interactive engagement pedagogy (as would typically be exemplified by a blended learning pedagogy integrating technology with in-person instruction)."

https://www.edx.org/blog/comparing-effectiveness-learning-moocs

2015:
110 STUDIES;
K-12
COLLEGE AND
ADULT

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The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis

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Teaching/learning strategies

ABSTRACT

Mobile devices such as laptops, personal digital assistants, and mobile phones have become a learning tool with great potential in both classrooms and outdoor learning. Although there have been qualitative analyses of the use of mobile devices in education, systematic quantitative analyses of the effects of mobile-integrated education are lacking. This study performed a meta-analysis and research synthesis of the effects of integrated mobile devices in teaching and learning, in which 110 experimental and quasiexperimental journal articles published during the period 1993–2013 were coded and analyzed. Overall, there was a moderate mean effect size of 0.523 for the application of mobile devices to education. The effect sizes of moderator variables were analyzed and the advantages and disadvantages of mobile learning in different levels of moderator variables were synthesized based on content analyses of individual studies. The results of this study and their implications for both research and practice are discussed.

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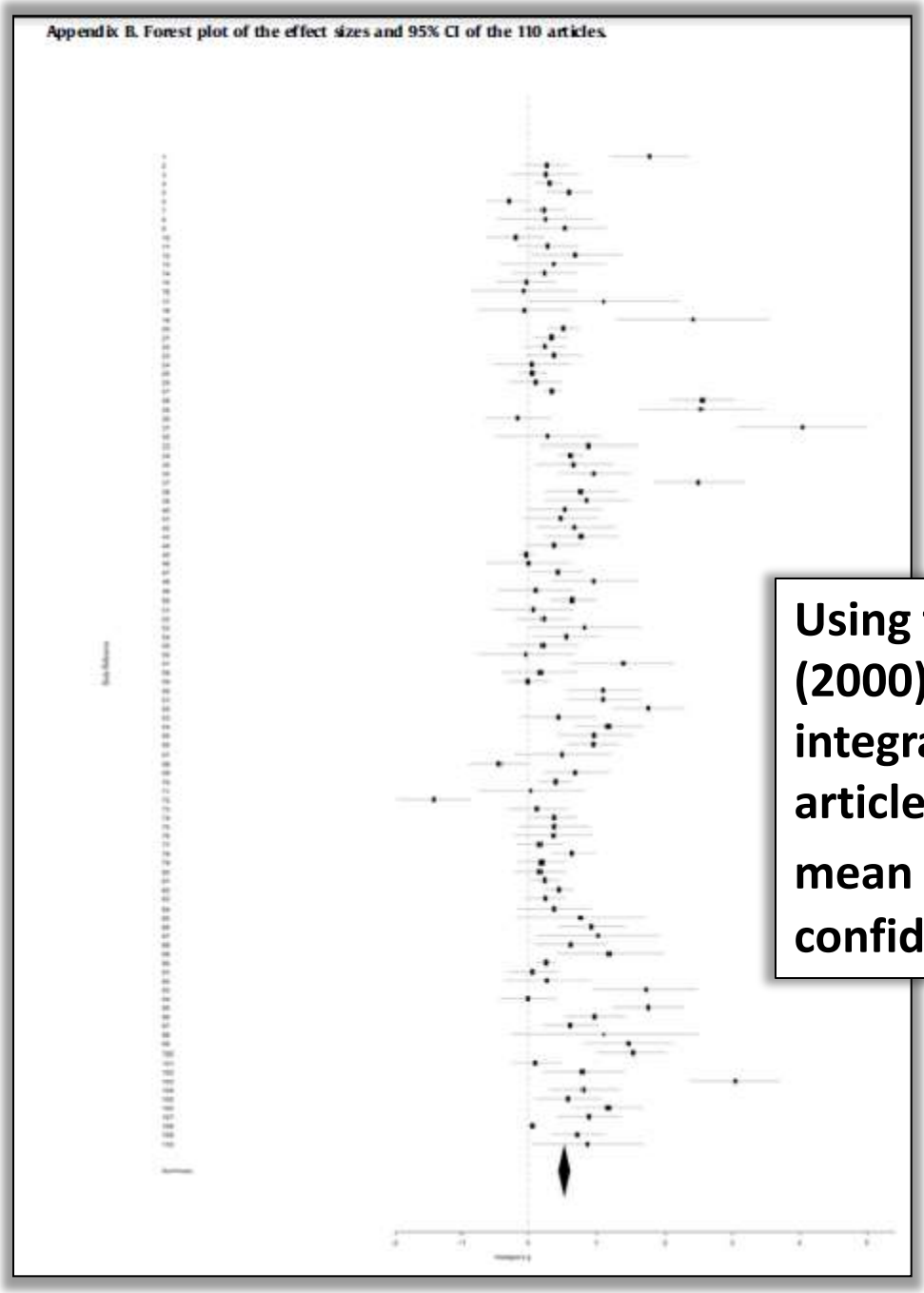
1. Introduction

1.1. Integrating mobile devices with learning and instruction

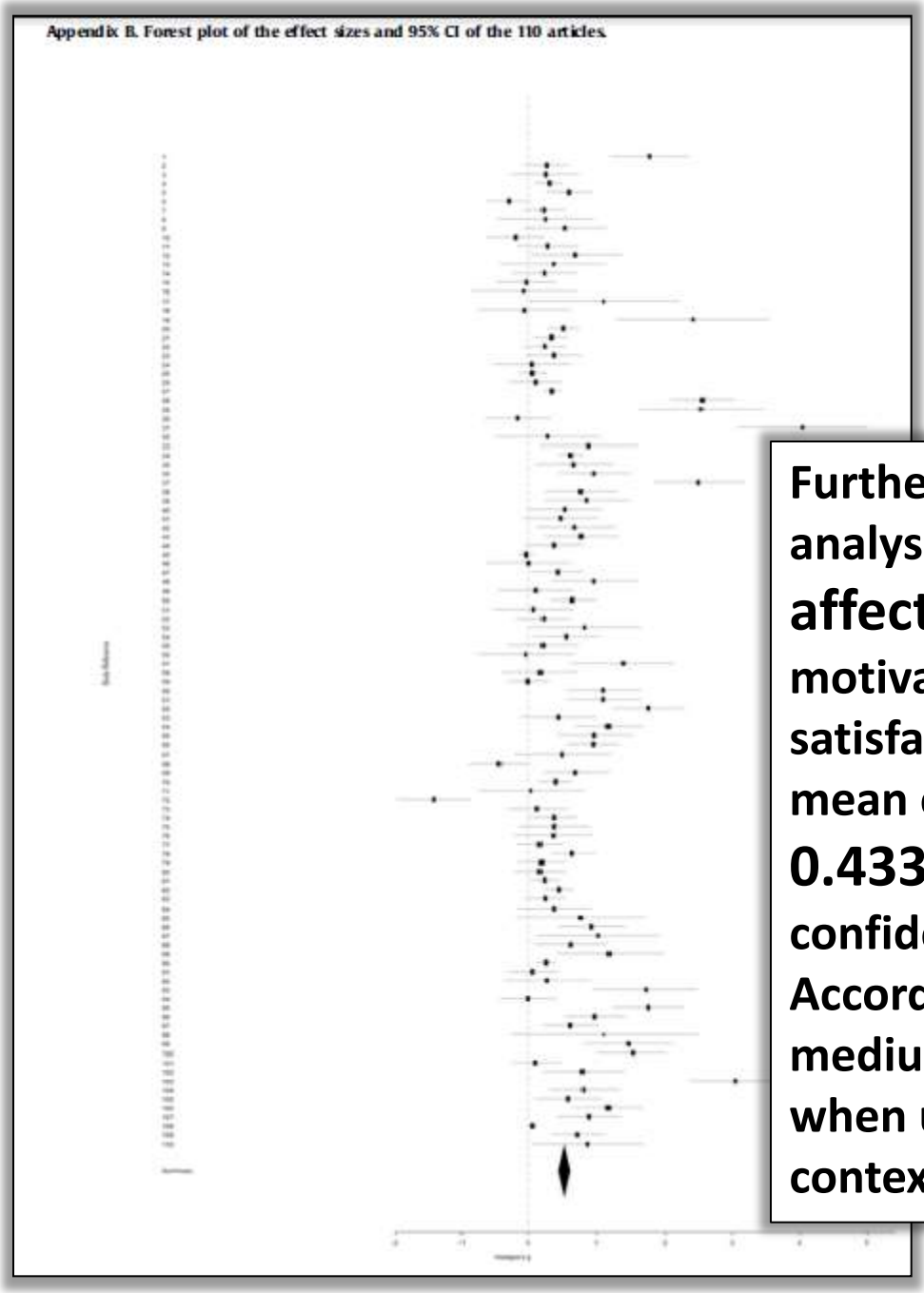
Mobile computers have gradually been introduced into educational contexts over the past 2 decades. Mobile technology has led to most people to carry their own individual small computers that contain exceptional computing power, such as laptops, personal digital assistants (PDAs), tablet personal computers (PCs), cell phones, and e-book readers. This large amount of computing power and portability, combined with the wireless communication and context sensitivity tools, makes one-to-one computing a learning tool of great potential in both traditional classrooms and outdoor informal learning.

With regard to access to computers, large-scale one-to-one computing programs have been implemented in many countries globally (Bebell & O'Dwyer, 2010; Fleischer, 2012; Zucker & Light, 2009), such that elementary- and middle-school students and their teachers have their own mobile devices. In addition, in terms of promoting innovation in education via

2015:
110 STUDIES;
K-12
COLLEGE AND
ADULT



Using the procedure of Lipsey and Wilson (2000) with a random-effects model to integrate the effect sizes of the 108 articles, there was an overall moderate mean effect size of 0.523, with a 95% confidence interval of 0.432-0.613.



2015:
110 STUDIES;
K-12
COLLEGE AND
ADULT

Furthermore, we also conducted an analysis for the studies related to the affective variables (such as motivation, engagement, attitude, satisfaction, preference). The overall mean effect size of the 22 articles was 0.433 (z ¼ 6.148, p ¼ .001), with a 95% confidence interval of 0.295-0.570. According to Hattie's criterion, there is a medium effect size for affective variables when using mobile devices in educational context.

"…the overall effect of using *mobile devices in education is better than when using desktop computers or not using mobile devices as an intervention, with a moderate effect size of 0.523*…

The effect of such usage was *greater for handhelds* than for laptops; usage in *inquiry-oriented learning* was more effective than usage along with lectures, self-directed study, cooperative learning, and game-based learning; *informal educational environments* were more effective than their formal counterparts, and medi*um- and short-duration interventions* were superior to long-term interventions."

"…However, it is note-worthy that the features of mobile devices are not sufficient conditions for positive learning effects. The minor effects of mobile-device-based cooperative and game-based learning in our study illustrated this fact. *Instructional strategies are important for effective learning with information technology*…"

"…As one of the most used strategies in mobile learning/teaching, *self-directed study* *is* an example of a method that deserves more attention paid to pairing specific features to specific challenges to yield improved results…"

AUTHORS	INDEPENDENT VARIABLE	DEPENDENT VARIABLE	WEIGHTED MEAN EFFECT SIZE
1991: *Kulik & Kulik**	COMPUTER TECHNOLOGY	LEARNER ACHIEVEMENT	.30
2000: *Roschelle et al.*	COMPUTER TECHNOLOGY	LEARNER ACHIEVEMENT	
2000: *National Assessment of Educational Progress*	SOFTWARE DESIGN	LEARNER ACHIEVEMENT	
2002: *Thompson*	BLENDED LEARNING	PERFORMANCE ON REAL WORLD TASKS AND TIMING PERFORMANCE	
2003: *Waxman et al.**	COMPUTER TECHNOLOGY	-LEARNER ACHIEVEMENT -LEARNER MOTIVATION	.410
2006: *Zhao et al. **	DISTANCE LEARNING	LEARNER ACHIEVEMENT	.10
2011: *Tamim et al. **	COMPUTER TECHNOLOGY	LEARNER ACHIEVEMENT	.30 - .35
2013: *Means et al. **	ONLINE LEARNING BLENDED LEARNING	LEARNER ACHIEVEMENT	.05 (online) .35 (blended)
2014: *Colvin et al.*	MOOCs	LEARNER ACHIEVEMENT	
2015: *Sung et al. **	LAPTOPS AND OTHER MOBILE DEVICES	LEARNER ACHIEVEMENT	.523

*meta-analysis

KEY OBSERVATIONS:

1. Positive outcomes have been low to moderate. F2F in many studies lower than with technology. Outcomes not due to superiority of medium but caused by content, pedagogy and learning time.

2. No single factor by itself produces a positive outcome. Results are due to interplay of various factors.

3. Certain factors recur and are consistent over time (varied interactions). Learning with technology involves different interactions.

WHICH IS MOST EFFECTIVE?

(1991-2015)

LOWER THAN ICT-SUPPORTED F2F, BLENDED LEARNING AND MOBILE AND DISTANCE LEARNING

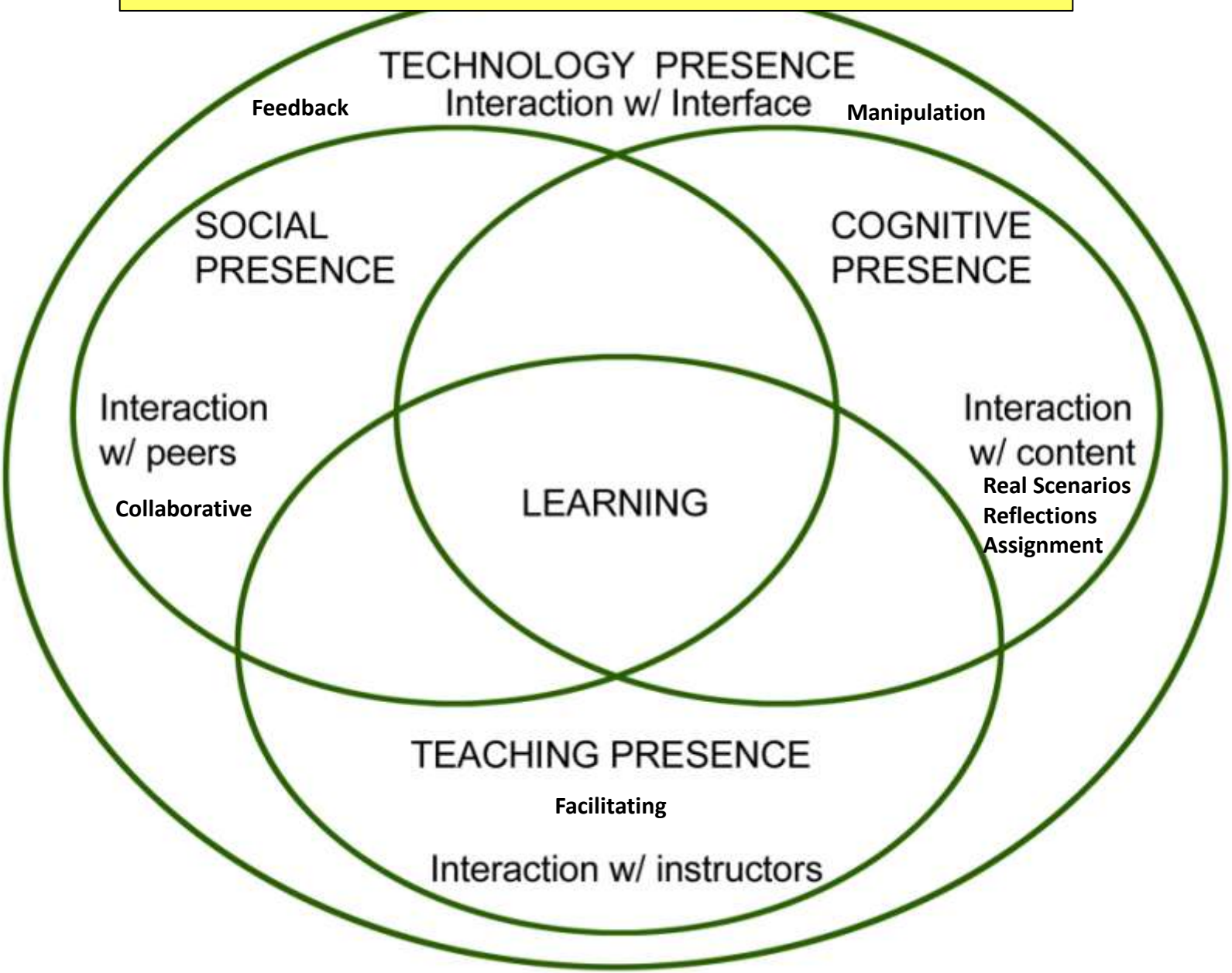
EFFECT SIZES BETTER THAN F2F RANGING FROM .30 - .410

EFFECT SIZE OF .35, BETTER THAN FACE-TO-FACE; WITH MOBILE DEVICES, ES = .523

EFFECT SIZE OF .05, BETTER THAN FACE-TO-FACE

WHAT DOES RESEARCH SAY?

INTERACTIVE LEARNING WITH TECHNOLOGY



Adapted from Moore

RAPATAN2017

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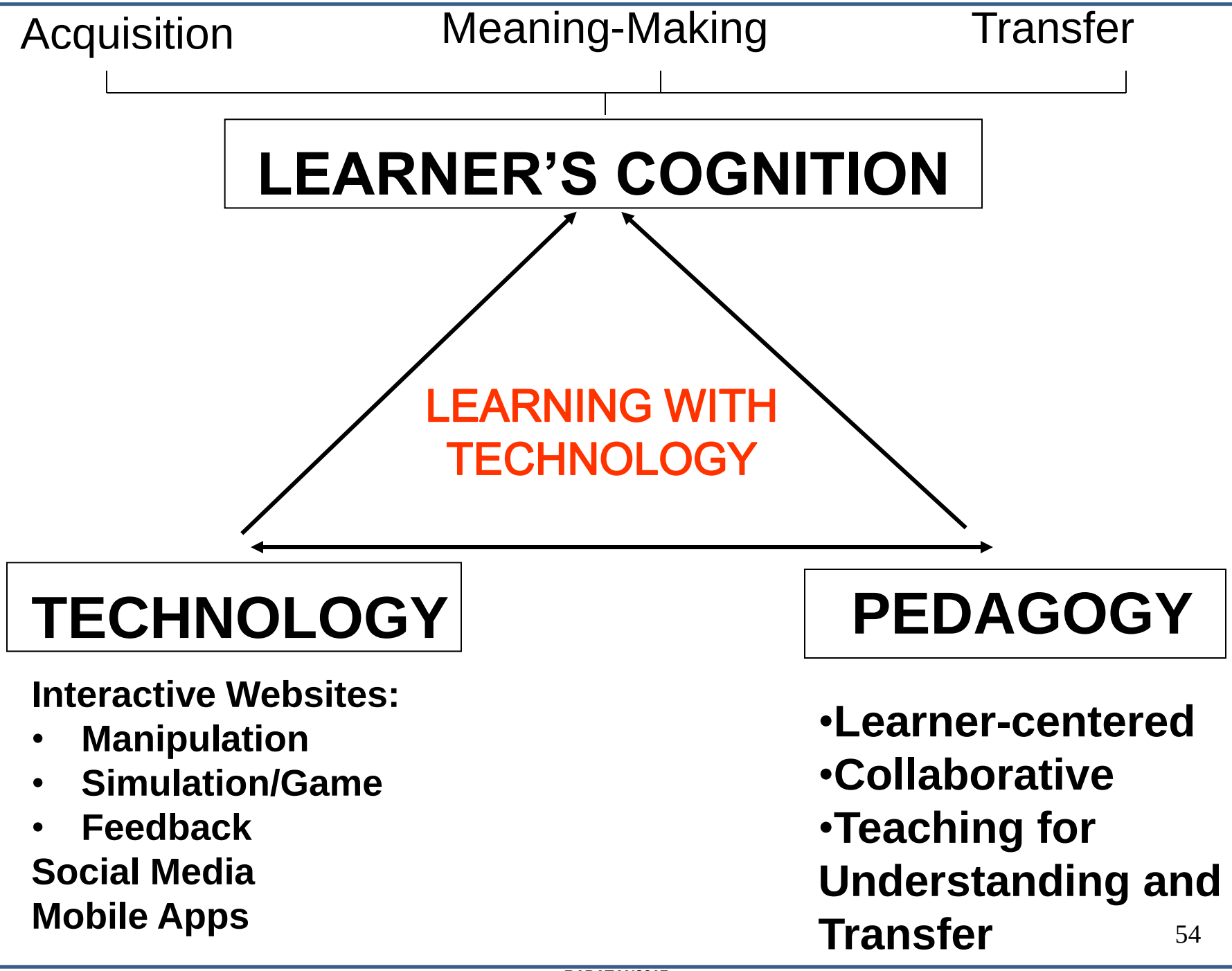
4. Learning with technology is a structured process. It involves a well-thought out design.

"This implies that we should learn not only how to use technology but to design interactive learning tools which embody our pedagogical beliefs and practices."


Acquisition
Meaning-Making
Transfer
LEARNER'S COGNITION
LEARNING WITH TECHNOLOGY
TECHNOLOGY
PEDAGOGY
Interactive Websites:
• Manipulation
• Simulation/Game
• Feedback
Social Media
Mobile Apps
•Learner-centered
•Collaborative
•Teaching for Understanding and Transfer

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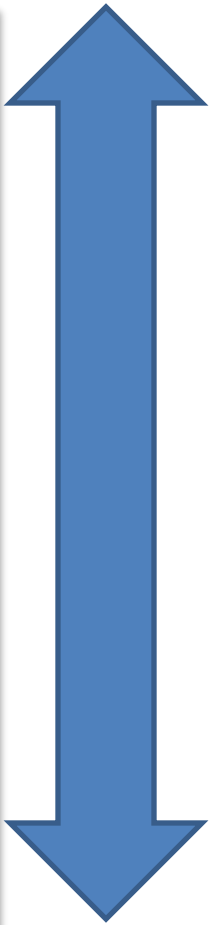
4. Learning with technology is a structured process. It involves a well-thought out design.

5. Good design considers the different conditions and practices cited in research. Learning with technology goes beyond mere delivery of information or operation of system tools.

EFFECTIVE PRACTICES/CONDITIONS FOR BLENDED LEARNING (2000-2010)

- **COLLABORATIVE**
- **INSTRUCTOR-LED**
- **INSTRUCTION ALIGNED WITH CURRICULUM**
- **INVOLVES MANIPULATIONS**
- **PROMPTED WITH REFLECTION QUESTIONS**
- **USE OF ASSIGNMENT**
- **USE OF SCENARIOS**
- **USE OF REAL WORLD TASKS**
- **IMMEDIATE INDIVIDUALIZED FEEDBACK**



INTERACTIONS

Pedagogical approach was found to moderate significantly the size of the online learning effect…

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