

EDUCATIONAL TECHNOLOGY NEWS

WELCOME

to the sixth edition of *Educational Technology News*, a biannual newsletter published by the Center for Technology at the North Central Regional Educational Laboratory (NCREL), a wholly owned subsidiary of Learning Point Associates. As one of 10 regional educational laboratories funded by the U.S. Department of Education, NCREL is a leading research laboratory, and its designated National Leadership Area is technology. In partnership with the North Central Eisenhower Mathematics and Science Consortium (NCEM-SC) and the North Central Regional Technology in Education Consortium (NCRTEC), we continue to enable hundreds of teachers, administrators, and policymakers to integrate technology effectively.

In this issue, we present a look at recent Center for Technology research and development efforts. In particular, we've included the following two articles: a summative, in-depth look at the research and findings of *A Meta-Analysis of the Effectiveness of Teaching and Learning With Technology on Student Outcomes* (full report available online-see article for details) and an informative peek at the content of NCREL's *Quick Key No. 7* about scientifically based research. Also appearing in this issue is an announcement about presentation materials from the 2004 National Educational Technology Conference held in conjunction with the 2004 NCREL Annual Conference March 10–11.

We thank you for your continued interest in our work and invite you to learn more about these and other Center for Technology research and resources by visiting our home page at www.ncrel.org/tech/. For more information about Learning Point Associates, please visit www.learningpt.org.

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Further Research Suggests Classroom Technology Use Has Positive Impact on Student Performance

By Robert Blomeyer and Rosalie Guerrero, NCREL Center for Technology

As states and school districts are increasingly required to choose evidence-based programs for their schools and classrooms to meet the scientifically based research requirements of the No Child Left Behind Act (2002), educational research must provide sound empirical evidence that programs and interventions are improving student academic outcomes. To address this need, NCREL commissioned a synthesis of scientifically based research on the impact of technology in teaching and learning on student outcomes.

The report from that synthesis, conducted by Hersh Waxman, Michael Connell, and Jon Gray (2002), examined 20 high-quality educational research studies on classroom instruction with technology. The researchers found evidence supporting a small, positive effect (.31) of teaching and learning with technology on students' cognitive, affective, and behavioral outcomes (Waxman et al., 2002). Given the small effect observed and the low number of studies highlighted in the report, NCREL continued its work with Dr. Waxman in 2003.

This work, *A Meta-Analysis of the Effectiveness of Teaching and Learning With Technology on Student Outcomes* (Waxman, Lin, & Michko, 2003), examines again the effects of teaching and learning with technology on students' cognitive, affective, and behavioral outcomes but with a larger sample. In this research report, 22 more high-quality studies were added to the 20 studies from 2002, resulting in a sample of 42 high-quality educational studies on classroom instruction with technology.

Analysis of the research contained in the 42-source synthesis shows a small, positive increase in the effect size from .31 to .40 (Waxman et al., 2003). This increased evidence of effect justifies greater confidence in the conclusion that classroom-level use of technology has a generally positive effect on students' cognitive, affective, and behavioral academic outcomes (Cohen, 1988).

While numerous meta-analyses have examined the effects of technology on student outcomes (typically achievement)—with several recent analyses focusing on the effectiveness of specific technologies—few have examined how technology is appropriately integrated into classroom instruction. In recent years, the rapid improvement in technology suggests that technology use examined in the past may look dramatically different today. The Waxman et al. (2003) study begins to address these issues by examining the effect of classroom-level technology use on student academic outcomes.

Purpose

The ability to examine differential effects of a treatment or intervention is one of the many advantages of using meta-analysis to aggregate and report educational findings (Hunter, Schmidt, & Jackson, 1982). As the Waxman et al. (2003) study continued the work begun in 2002, its purpose was to synthesize recent research on the effects of teaching and learning with technology on student outcomes. The researchers set out to answer the following questions:

- How extensive is the empirical evidence on the relationship between teaching and learning with technology and student outcomes?
- What is the magnitude and direction of the relationship between teaching and learning with technology and student outcomes?
- Are there certain social contexts or student characteristics that affect the relationship?
- Are there particular methodological characteristics that affect the relationship?
- Are there specific characteristics of the technology that affect its relationship with student outcomes?
- Are there specific characteristics of instructional features that affect technology's relationship with student outcomes? (Waxman et al., 2003, p. 6)

Method

From the 42 studies analyzed, Waxman et al. (2003) identified and coded common core characteristics of technology, teaching, and learning (see Table 1 on page 4). The common characteristics of technology were adapted from previous meta-analyses in this area, while the teaching and instructional characteristics were adapted from *The Five Standards for Effective Pedagogy* developed by the Center for Research on Education, Diversity, and Excellence (2002). (The list of coding categories used in this study can be viewed at www.ncrel.org/tech/effects2/appendx.htm.)

Findings

Approximately 40 percent of the studies focused on elementary school (Grades K–5), 40 percent on middle school (Grades 6–8), and 20 percent on secondary school (Grades 9–12). Thirty percent of the meta-analysis studies identified schools that use personal computers, 26 percent that use networked laboratories, and 5 percent that use multimedia. The other 39 percent identified schools that use a variety of other technology resources. The most commonly reported (31 percent) uses of instructional software were in an exploratory environment such as simulations, hypermedia, and hypertext, with a few using drill-and-practice software or other productivity tools.

The study looked at three types of student outcomes: cognitive, affective, and behavioral. The most commonly reported cognitive outcomes were researcher-based tests, authentic assessments, and standardized tests. The majority of affective outcomes were student attitudes about computers, followed by students' motivation or self-concept. Behavioral outcomes were most frequently reported as the number of tasks attempted, followed by time students spent on task and perseverance. Overall, the mean study-weighted effect sizes averaging across all outcomes was .41 ($p < .001$), with a 95-percent confidence interval of .17 to .64 (Waxman et al., 2003). According to the researchers, "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" (Waxman et al., 2003, p. 11).

Discussion

Waxman et al. (2003) went to great lengths to ensure that the meta-analysis included high-quality research studies; however, the researchers point out several limitations of this study. Research quality was a great concern, as few examples of sound research were found suitable for this study. Many studies were not included on the basis that they had reported data that

did not permit the calculation of effect sizes, they had not used an experimental design, or they had neglected to report sufficient details to allow adequate coding of study characteristics.

Other limitations of the meta-analysis are related to the study design. First, due to the correlational nature of meta-analysis results, causal inferences based on these results are not recommended. Second, meta-analyses do not have any control on original data; subsequent analyses are limited by the quality of the primary studies. Third, only refereed journal articles were included; other research available via Web sites, books, chapters, dissertations, conference proceedings, and technical reports was excluded because of quality concerns. Finally, this work is limited by the relevance of the research analyzed: A few of the studies reviewed took place in the early '90s; therefore, the technology used in the earlier studies is now at least a decade old.

Conclusions

The results of this analysis indicate that overall the effects of teaching and learning with technology on student outcomes are at least twice as large as, and may be greater than, reported in the 2002 meta-analysis conducted on instructional technology. However, the researchers maintain that there are still questions regarding the effects of teaching and learning with technology on student outcomes (Waxman et al., 2003).

In attending to these important questions (as they concern the impact of classroom-level technology use on student academic outcomes), we need additional high-quality educational research that addresses the issues and questions defined by the Instructional/Teaching Characteristics and the Technology Characteristics (see Table 1). It isn't enough to simply claim that "more research" on technology and learning can or will make a difference. Additional experimental and quasi-experimental research studies are needed that adhere to the highest standards for quality and address the critical common core of technology and instructional factors defined by the Waxman protocol (explained in the report's Method section [available at www.ncrel.org/tech/effects2/method.htm], which covers the review criteria and research synthesis techniques used in the meta-analysis).

A Meta-Analysis of the Effectiveness of Teaching and Learning With Technology on Student Outcomes is available on the Center for Technology's *Technology in Education* Web site at www.ncrel.org/tech/effects2/.

Table 1. Common Core Characteristics of Instruction/Teaching and Technology in the Classroom*

Instructional/Teaching Characteristics

- **Joint Productive Activities** – collaborative instructional activities required and positively supported
- **Language and Literacy Development** – student language and literacy connected to content-area knowledge
- **Contextualization/Making Meaning** – using real-world examples to express understanding
- **Challenging Activities** – advancing students' understanding to more complex levels
- **Instructional Conversation** – frequent or regular facilitation of conversations regarding students' views, which are supported by resources
- **Setting** – classroom, networked classroom, or computer laboratory
- **Mode of Instruction** – whole-group to individual
- **Role of Teacher** – lecturer, facilitator, modeling, or mixed
- **Teacher Qualifications** – alternatively certified, certified in content area, not certified

Technology Characteristics

- **Type of Technology** – type of hardware and network availability
- **Software** – tutorials, drill and practice, exploratory/simulations, productivity tools, programming
- **Technology Resources and Support Availability** – minimal to ample
- **Role/Focus of Technology** – purpose of use: unspecified, productivity, delivery system, or resource
- **Quantity of Technology** – little (fewer than three) to ample (more than nine per room)
- **Number of Computer Sessions** – the reported number
- **Duration of Computer Sessions** – average number of minutes per session
- **Teachers' Experience with Technology** – unspecified to very experienced
- **Students' Experience with Technology** – unspecified to very experienced
- **Teacher Training in Technology** – number of hours of training
- **Feedback and Assessment Practices** – no feedback, minimal, or elaborate
- **Learning Responsibility** – student-, teacher-, or system-directed; or mixed
- **Task Difficulty** – difficult, moderately difficult, not difficult, or mixed
- **Type of Learning Task** – basic skills, problem solving, inquiry, or mixed
- **Type of Technology Program** – basic skills, problem solving, inquiry, or mixed
- **Pattern of Student Computer Use** – teacher use, presentation station, number of students per computers
- **Percentage of Student Computer Use** – percentage reported
- **Objectives of Computer Use** – remediation, writing, communication, research, analysis, presentation, collaborative, or independent work

* Skills were identified based on the 42 studies included in the 2003 meta-analysis.

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NCREL Quick Key No. 7: A Foundation for Understanding and Evaluating Scientifically Based Research

New in the
Center for Technology

By Matt Dawson, NCREL Center for Technology

One of the underlying principles of the No Child Left Behind (NCLB) Act of 2001 is that school reform efforts to improve student academic achievement must be based on “scientifically based research” (NCLB, 2002). This phrase, while seemingly innocuous, has several implications for school leaders as well as teachers.

With this fundamental NCLB principle in mind, Learning Point Associates has published *Quick Key No. 7, “Understanding the No Child Left Behind Act of 2001: Scientifically Based Research.”* It was developed to provide a brief overview of what scientifically based research means for educators and administrators by demystifying the three types of research: theoretical, correlational, and causal. This latest *Quick Key* covers two main topics: (1) the definition of scientifically based research, including practical examples to help demonstrate the concepts; and (2) a general discussion of research, as it provides a basis for understanding and evaluating research claims.

Quick Key No. 7 joins the series of previous topics assembled to help educators and administrators respond to the NCLB Act:

- “Understanding the No Child Left Behind Act of 2001: Reading” (*Quick Key No. 1*)
- “Understanding the No Child Left Behind Act of 2001: Opportunities for Schools in Need of Improvement” (*Quick Key No. 2*)
- “Understanding the No Child Left Behind Act of 2001: Technology Integration” (*Quick Key No. 3*)
- “Understanding the No Child Left Behind Act of 2001: Mathematics and Science” (*Quick Key No. 4*)
- “Understanding the No Child Left Behind Act of 2001: English Proficiency” (*Quick Key No. 5*)
- “Understanding the No Child Left Behind Act of 2001: Teacher Quality” (*Quick Key No. 6*)

Quick Key No. 7 serves as a foundation built to provide a clear understanding of what scientifically based research is and what it is not. In particular, the NCLB Act (2002) lays out six components of scientifically based research:

- Empirical methods are used to carry out the research, which is conducted in a systematic and consistent manner, with keen attention to detail.
- Data collection and analysis are rigorously conducted to ensure that the data are collected, analyzed, and interpreted correctly.
- Measurements or observational methods that provide scientifically valid and reliable measurements across many different measurement points and observations are used.
- The studies employ experimental or quasi-experimental methodology to optimize the researchers’ ability to answer the questions under investigation.
- Enough data and description should be provided so that future researchers can attempt to replicate the findings by conducting a study using the same methods and instruments.
- An independent, objective, and rigorous external review of the research has taken place.

These requirements are important to remember, in that while there may be many studies that show some sort of impact, only studies that meet the six criteria above will be considered scientifically based research according to the tenets of the NCLB legislation. Knowing the principle requirements of the NCLB Act is a necessary early step in understanding and evaluating scientifically based research. With these six requirements in mind, one can better evaluate the various kinds of research and how certain research may connect to practice.

In order to meet the criteria set forth in the NCLB legislation, school leaders must find ample research-based evidence for their reform program of choice. Finding scientifically based research and building a cumulative research base is certainly a daunting task, but *Quick Key No. 7* is a resource developed to help school leaders understand, evaluate, and conduct scientifically based research.

Quick Key No. 7 is available on the Learning Point Associates Web site at www.ncrel.org/csri/tools/qkey7/index.html. To order print copies of this or other resources, visit the Learning Point Associates Product Catalog at www.learningpt.org/catalog.htm.

Reference

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Making Good Choices in Education: More Than Just the 2004 NCREL Conference Theme

In the Spotlight

By Nicole Gallmann, NCREL Center for Technology

The 2004 National Educational Technology Conference, held in conjunction with the 2004 NCREL Annual Conference on March 10–11 in Naperville, Illinois, was attended by a record number of participants. In addition to its guidance as a conference theme, “Making Good Choices in Education” gave voice to the drive and determination of so many educators who approach educational technology concerns each day with innovative strategies and tools, prompting those attending the conference to join in the conversation. The dedication of this year’s conference presenters and participants will continue

to shape and further apprise the work of the Center for Technology, as well as that of countless practitioners, policymakers, researchers, and other stakeholders, about making not only good, but informed, choices in education.

For panel and breakout session presentations, handouts, abstracts, presenter and participant lists, and archived conference summaries, please visit the *National Educational Technology Conference* Web site at www.ncrel.org/tech/netc/. We look forward to seeing you at next year’s conference scheduled for March 9–10, 2005. ■

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Available online at www.ncrel.org/tech/etnews

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This work was originally produced in whole or in part by the North Central Regional Educational Laboratory with funds from the Institute of Education Sciences (IES), U.S. Department of Education, under contract number ED-01-CO-0011. The content does not necessarily reflect the position or policy of IES or the Department of Education, nor does mention or visual representation of trade names, commercial products, or organizations imply endorsement by the federal government.

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.

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