ISSUE BRIEF
Charles A. Dana Center
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Making Sense of Research for Improving Education

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Research should guide decisions about how to improve student achievement. It should allow education practitioners to evaluate and compare various programs for improving education and select the programs most likely to help their local students and schools. Research should also help practitioners reduce the variation in performance across schools and classrooms by showing how to raise achievement for more students.

The No Child Left Behind (NCLB) Act of 2001 requires that schools and districts receiving federal money use their funds on evidence-based strategies for supporting student achievement. In particular, NCLB promotes "scientifically based research"—that is, research that applies empirical methods to experimental or quasi-experimental research designs (see table 1). Currently there are few such studies that provide evidence of the effect of educational programs and strategies on student success, though NCLB requirements will likely elicit more experimental and quasi-experimental research on educational strategies. Other research methodologies—such as correlational studies and case studies—have also provided evidence of successful student support strategies.

This issue brief is designed to help education practitioners—teachers, school district staff, and other educational leaders—clarify their understanding of what scientifically based research is and learn more about several research designs used in education research. This brief is divided into three sections.

- *The first section briefly describes current research language and classifications of research. (page 1)*
- *The second gives recommendations for using research to make decisions about teaching and learning. (page 3)*
- *The third discusses measuring and collecting the right data, using mathematics education in Texas as an example. (page 4)*

1 Classifications of Research

Recent discussions associated with educational research use the terms scientifically based research, evidence-based education, and scientific research almost interchangeably, but the terms are not synonymous.

NCLB defines **scientifically based research** as "research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs." Among other requirements, scientifically based research "employs systematic, empirical methods"; "involves rigorous data analyses"; and "is evaluated using experimental or quasi-experimental designs" that control for several variables (section 9101(37)).

Evidence-based education is more broadly defined than scientifically based research. According to Grover (Russ) Whitehurst, Director of the Institute of Education Sciences (2002), evidence-based education is "the integration of professional wisdom with the best available empirical evidence in making decisions about how to deliver instruction" (slide 2).

In comparison, a 2002 report by the National Research Council defines **scientific research** as research that adheres to certain broad scientific principles. The report suggests that these scientific principles can be applied to several forms of

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research, including, but not limited to, the experimental and quasi-experimental designs specifically referred to in the NCLB's definition of *scientifically based research*.

In addition to experimental and quasi-experimental designs, other research designs, each involving different forms of information and evidence, can be used to guide practitioner decisions about strategies for supporting student achievement. Table 1 presents four different research designs and provides examples of each.

Table 1. Features of four common research designs

DESIGN	FEATURES	EXAMPLE
Experiment	Experimental studies seek to establish cause-and-effect relationships by examining whether changes in one variable systematically affect another variable. Random assignment is an important feature of experimental studies. Since students, classes, or schools are randomly assigned to be in one of several groups, researchers can calculate confidence measures indicating the likelihood that differences in outcomes are due to the intervention being studied.	A study examining the effects of a middle school mathematics intervention that randomly assigns classes of students to either participate in the intervention or not. Researchers attempt to keep constant all contributing factors other than the intervention.
Quasi-Experiment	Quasi-experimental studies do not use random assignment to groups, but instead make comparisons among groups before and after an intervention or between two groups that are matched (i.e., similar) on important characteristics assumed to influence the outcome of interest.	A study examining the effects of a middle school mathematics intervention by comparing classes of participating students to classes of nonparticipating students who are matched by contributing factors other than the intervention, such as the students' socioeconomic background.
Correlational Study	Correlational studies are descriptive studies that determine the strength of a relationship between two variables. They do not allow researchers to determine cause/effect. They can be conducted with or without statistical controls. They can be used to determine if groups behave differently, but they do not give evidence as to what caused the difference. Results from correlational studies can be used to provide insights about which relationships should be further investigated to determine causality.	A study that examines the relationship between taking Algebra II in high school and higher earnings as an adult. The existence of this relationship does not imply that requiring all students to enroll in Algebra II will result in all students' earning higher salaries as adults, since the relationship does not imply cause/effect.
Case Study	Case studies collect and present detailed information about a particular participant or small group. Case studies can be descriptive research studies of process and implementation issues to examine how, why, and under what conditions a program works. They can give insights about which relationships should be further investigated to determine causality. They can be used to identify the factors that contribute to improvements.	A study that examines and details common factors of a small group of schools that successfully serve students from economically disadvantaged backgrounds.

Any study might ultimately use more than one research design and more than one methodology within those designs. The research designs selected for any given study should be chosen based on what the researchers are seeking to discover. That is, some designs and methods are more suitable for certain types of questions. For example, to study the effect of a certain program on student success, researchers would investigate questions such as the following:

- *What factors should we consider when we study this program? What measures do we need to determine the effectiveness of the program? Are these measures reliable and valid? That is, do they consistently and accurately measure goals?*
- *Is there evidence that this program improves student learning?*
- *How and under what conditions is this program effective?*

While scientifically based research is necessary to attribute *cause and effect*, other methods—such as correlational studies and case studies—explore the *impact* of a program. In particular, correlational studies and case studies can identify factors for researchers to further examine or control for in experimental designs.

Correlational studies and case studies are useful not only because they can provide guidance for the design and methodology of experimental studies but because they can also provide information that cannot be discovered through experimental studies. For example, process and implementation issues of how and under what conditions a program is effective lend themselves to correlational studies and case studies. Together with scientifically based research, these approaches add different perspectives, but ultimately any research used to evaluate program effectiveness should converge on interconnected findings. Education researchers and practitioners must be careful not to conclude that No Child Left Behind implies that scientifically based research is the only or the "best" research that should be funded. Instead, education researchers and practitioners must continue to develop a broad, balanced research base that includes different types of research to ensure that a full picture is presented of what is effective.

Research can help practitioners make decisions by answering questions such as, "Is there evidence that this approach is effective?" as well as, "Why and how is this approach effective?" Studies with different purposes need different designs and implementations.

2 Using Research to Make Decisions About Teaching and Learning

One way to search for published education research is to use databases such as the Educational Resources Information Center (ERIC) at *www.eric.ed.gov*. In addition, the U.S. Department of Education is creating the What Works Clearinghouse at *www.w-w-c.org* to provide information on research that meets the criteria established by NCLB.

While investigating research that appears applicable to their situation, practitioners must examine its validity and reliability. **In particular, practitioners should consider the research's relevance, generalizability to their specific circumstances, statistical soundness, and preponderance of evidence.**

Relevance

As practitioners make decisions about what strategies and programs to adopt in order to help their students succeed, they must consider not only the available research and evidence, but also their professional wisdom. The instructional programs adopted must be grounded in the values, beliefs, and desired outcomes of the school and district. Practitioners must consider the consequences of choosing specific research-based strategies, as well as other ways of achieving long-term and immediate goals. To guide their decisions, practitioners can ask themselves questions like

- *Do the outcomes of the researched strategies align with our goals?*
- *Are the goals of the strategies aligned with our state's curriculum guidelines?*
- *Were the approaches and outcomes sufficiently defined so that we can determine whether the approaches could be locally implemented and whether the outcomes appear to be aligned with local goals? How did the researchers investigating the strategies measure success? Was their evaluation based on test scores only? What other measures of success did they use?*

Generalizability

What works in education depends so much on the population and the setting that some research findings may not generalize to other places and types of students. Practitioners should check to see whether the strategies were tested with participants and environments similar to their own. To guide their decisions, practitioners can ask themselves questions such as

- *Have the research results been replicated and do they generalize to other settings?*
- *Do the program's approaches fit our local circumstances?*
- *Is there evidence that this program will work for us?*

Statistical soundness

Before making costly decisions practitioners should consult with experts who understand evidence and can help interpret its significance and value. Practitioners can work with experts to determine the answers to questions like

- *Were the research design and methods used appropriate and effective for answering the questions the researchers posed?*
- *Were the groups studied free of bias in their selection and of adequate size to draw conclusions?*
- *Were the research design and methods appropriate for the type of data the researchers collected?*
- *Was the study clear, complete, and replicable?*
- *Was there evidence that the strategies were the cause of the positive changes the researchers observed? How strong was this evidence?*

Preponderance of evidence

When taken as a whole, the body of research should provide strong evidence pointing in a clear direction. When examining research, practitioners must be sure to follow logical and clear chains of reasoning in the body of research while questioning conclusions that seem biased. In addition, practitioners should carefully distinguish between what the *research* says and what the *researcher* says. Practitioners can ask themselves questions such as

- *What is the evidence that demonstrates the effectiveness of the strategies described in this research?*
- *What is the strength of this evidence?*
- *Does the research fit within a larger network of converging evidence and relevant theory?*

In addition to looking at what evidence exists, practitioners may also need to consider what evidence does *not* exist, and why. For example, an innovative program might not yet have collected evidence of its effects using scientifically based research designs. However, if there is other strong evidence suggesting that this program is relevant and likely to be effective for their specific circumstances, practitioners should not summarily dismiss it without further investigating whether it is a program that could benefit their students. For example, if a program were built upon basic education research principles about “what works” or if there were some observational evidence that a program qualifies as a “best practice,” then practitioners should examine this program further for alignment to local circumstances.

As well as using research to select programs and strategies to address local issues, practitioners must routinely conduct evaluations of their own program implementation and success. One way to monitor progress is to use data, such as student assessment scores, course-taking patterns, or attendance, to measure advancement toward objectives. Practitioners must decide what their goals are, what it means to be successful, and how they can measure success, and then devise a plan to collect data, evaluate it, and determine what constitutes evidence. Here again, practitioners may wish to consult experts with experience in efficiently and accurately collecting and evaluating information to answer their questions.

3 Measuring and Collecting the Right Data: Mathematics Example

To make research-based decisions about which strategies to use to support student success, education practitioners must first agree on what it means for a student to be successful, in terms of long-term and short-term goals. The remainder of this brief uses the example of mathematics teaching and learning in Texas to suggest what to consider when determining if a particular strategy “works.”

To describe what it means for students to be successful in mathematics, the National Research Council’s 2001 report, *Adding It Up,* defines “**mathematical proficiencies**” through five interdependent strands, emphasizing no strand over the others: (pp. 116–133)

- *Conceptual understanding* refers to the student’s comprehension of fundamental ideas that goes beyond knowing isolated facts and procedures to making connections and seeing common patterns in superficially different situations.
- *Procedural fluency* includes being fluent with procedures as well as knowing when and how to use these procedures appropriately.
- *Strategic competence* means being able to formulate problems mathematically and devising strategies for solving them.

- *Adaptive reasoning* implies using logic to explain and justify a solution to a problem as well as extending from something known to something not yet known.

- *Productive disposition* refers to a disposition that allows one to continue to develop mathematically since mathematics is seen as sensible, useful, and doable.

The overriding argument of *Adding It Up* is that from prekindergarten through the eighth grade, all students can and should be mathematically proficient. For this to happen, curriculum, instruction, and assessment should all contribute to the goals of mathematical proficiency. Efforts to achieve this must be coordinated, comprehensive, and informed by scientific evidence. Hence, research on student achievement in mathematics should move toward objectively measuring student progress toward proficiency in all these strands.

In the past, views of mathematics learning have tended to emphasize just one aspect of proficiency, with the expectation that others would develop as a consequence. All five strands together give a more rounded portrayal of successful mathematics learning.

Example: Measuring Mathematical Proficiency in Texas

Texas has made great leaps in defining goals and aligning curriculum, instruction, and assessment through the Texas Essential Knowledge and Skills (TEKS) and Texas Assessment of Knowledge and Skills (TAKS). The TEKS describe what a student should know and be able to do in every subject for each grade, K–12, and the TAKS is the state assessment tool that measures attainment of the goals described in the TEKS. While the TEKS are designed to cover all strands of mathematics proficiency, not all can be tested through the TAKS format.

To measure student achievement in all five strands of mathematics proficiency, researchers and educators will need to consider and develop additional measures beyond TAKS results. For example, besides the TAKS, an evaluation package might include benchmarks that take in classroom observations to monitor student progress in all of the strands.

Conclusion

Educators should examine research to inform decisions for improving student achievement, beginning with first characterizing success. When education researchers and practitioners examine existing research, they see a steadily growing body of knowledge about how children learn, yet there is so much more to be identified. Education researchers and practitioners must continue to build on current education theories and research. They can do this by routinely gathering and using evidence to develop a balanced array of studies investigating how best to increase the success of all students.

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