Scientific Culture and Educational Research

by Michael J. Feuer, Lisa Towne, and Richard J. Shavelson

The No Child Left Behind Act of 2001 requires federal grantees to use their funds on evidence-based strategies. The law includes definitions of research quality, which are also featured prominently in the administration's strategic plan and in draft language for the reauthorization of the U.S. Office of Educational Research and Improvement. These initiatives pose a rare opportunity and formidable challenge to the field: What are the most effective means of stimulating more and better scientific educational research? In this article, which draws on a recently released National Research Council report, the authors argue that the primary emphasis should be on nurturing and reinforcing a scientific culture of educational research. Although the article focuses on scientific research as an important form of educational scholarship, the call for building a stronger sense of research community applies broadly. Specifically, the authors argue that the development of a scientific culture rests with individual researchers, supported by leadership in their professional associations and a federal educational research agency.

To rejoice or to recoil: That is the question faced by educational researchers today. Unprecedented federal legislation exalts scientific evidence as the key driver of education policy and practice, but—here's the rub—it also inches dangerously toward a prescription of methods and a rigid definition of research quality.

The good news, surely, is that the American people through their elected leaders are (again) manifesting their faith in science as a force for improved public policy. Amid the cacophony of reform proposals and the relentless barrage of data on every aspect of schools and schooling, decision makers at all levels are clearly thirsting for the rational and disciplined evidence provided by science. The No Child Left Behind Act of 2001 (HR1), which reauthorizes the Elementary and Secondary Education Act and provides billions of dollars in federal aid, contains 111 references to "scientifically-based research"—already granted acronym status inside the Beltway as SBR. In all areas of the law's broad reach, including the big ticket items—teacher quality, safe and drug-free schools, and Title 1—states and localities will have to demonstrate that they plan to spend those funds on programs with a scientific track record.[1] After years of envy for federal support received by their compatriots in medical, technological, agricultural, and physical research, educational researchers can now rejoice: Research is in.[2]

Educational Researcher, Vol. 31, No. 8, pp. 4–14

And yet there is trepidation in the ranks. Educational researchers, like other researchers, worry that the good intentions[3] underlying the SBR movement will go awry, that narrow definitions of *research* or *science* might trivialize rather than enrich our understanding of education policy and practice, and that the splendors of unfettered scholarship will be eroded by creeping tides of conformity and methodological zealotry. Almost everyone can appreciate, intuitively, the advantages of evidence-based policy; it is another matter entirely to make this concept clear, operational, and valid. And it is another matter still to know if and how the field should respond; this is our topic. In this article we make the following arguments:

1. Nurturing and reinforcing a scientific culture of educational research is a critical task for promoting better research.
2. Scientific culture is a set of norms and practices and an ethos of honesty, openness, and continuous reflection, including how research quality[4] is judged.
3. Individual researchers and research institutions have the responsibility for developing a scientific culture.
4. A federal educational research agency and the American Educational Research Association (AERA) can and must play crucial leadership roles in fostering, supporting, and protecting a scientific culture among their grantees and members.

In making these arguments, we draw heavily from a recent report of the National Research Council (NRC) of the National Academies[5] (NRC, 2002)—authored by a committee of scholars inside and outside of education and educational research[6]—that articulates the nature of scientific research in education and offers a framework for the future of a federal educational research agency charged with supporting high-quality scientific work.

Background

Why the National Academies

This was not the first time that the federal government approached the National Academies or NRC for advice about educational research. In *A Proposed Organization for Research in Education* (1958), NRC recommended establishing a research organization for advancement and improvement of education; *Fundamental Research and the Process of Education* (NRC, 1977) called for basic research into educational processes; and *Research and Education Reform: Roles for the Office of Educational Research and Improvement* (NRC, 1992) laid the groundwork for a complete overhaul of the federal educational research agency.

The federal government's involvement of the National Academies reveals a number of underlying assumptions: First, educational research can or should be at least in part scientific. Second, the federal government specifically seeks scientific research for policy and practice decisions. Third, the quality of educational research is wanting. And fourth, consideration of the scientific

basis of educational research is itself worthy of scientific attention and should be at least partly shielded from political influence.

Recent law and impending federal policy put those assumptions into particularly sharp relief. Continuing a growing trend, Congress has codified into the most important elementary and secondary education legislation a set of requirements for SBR as a condition for receipt of federal funds. Moreover, draft language authored by Representative Michael Castle (Delaware) for reauthorization of the U.S. Office of Educational Research and Improvement (OERI), on the Congressional agenda for this year, attempts to define—in law—scientifically valid quantitative and qualitative methods, issues that are obviously more commonly treated in textbooks. The current Department of Education's Strategic Plan (http://www.ed.gov/pubs/stratplan2002-07/index.html; see Goal 4) reinforces the general principle and moves even closer to precise definitions of research quality. The unmistakable theme is for more experimentation as the basis for sound policy judgments, an issue that has been the subject of longstanding debates in the field (Boruch, DeMoya, & Snyder, in press; Cronbach et al., 1980; Cronbach, 1982; Guba & Lincoln, 1981).

Academic scientists are usually startled to find the arcana of their craft inserted in law; but surprise turns to anxiety when the law appears to instruct them on methodology and to tie public funding of research to specific modes of inquiry. The combined force of HR1 and the impending OERI reauthorization has rekindled old debates over the nature of educational research and has spurred scientists in many domains to reexamine the nature of scientific inquiry in a democracy: For many, the key question is whether legislators or scientists should ultimately decide issues of research method.

At one level, then, there is a familiar collision between science and politics, between the culture of free inquiry that bristles at governmental encroachment and the equally compelling culture of democratic accountability that demands evidence that public monies are wisely spent.[7] In fact, though, it is not solely or even mostly a conventional debate about control and funding levels for science. That would presuppose at least some amount of agreement that educational research can be scientific and a consensus on its defining scientific qualities. We believe that by requesting a study on this topic the National Educational Research Policy and Priorities Board (NERPPB), the policy arm of OERI, was again acknowledging (a) that fundamental definitional problems need to be addressed first; (b) questions of scientific method in education can easily become politicized but need to be treated scientifically; and therefore (c) the logic in approaching the institution that has been independently advising government about science, technology, and the public interest for the last 138 years (Alberts & Feuer, in press).

Some Caveats

First, the NRC committee (NRC, 2002) did not offer blanket judgments about the quality of the field or the institutions that support it.[8] The committee did acknowledge that educational research suffered from uneven quality, noting that this was also true of most fields. Similarly, if we (the article's authors) had a bias, it would be that conventional wisdom about the weaknesses of scientific educational research relative to other sciences is exaggerated, and the criticisms would be equally worthy of serious investigation if leveled at other branches of the social and physical sciences or at other applied fields like medicine or agriculture.

However, we do have evidence to support the contention that educational research is perceived to be of low quality. Lack of confidence in the quality of educational research is certainly not limited to federal lawmakers. Nor has it prevented them from demanding more of it.[9] Educational researchers themselves are often their own harshest critics (e.g., Kaestle, 1993). They are often joined by a chorus of social and physical scientists, engineers, and business leaders who lament weak or absent theory, accumulations of anecdote masquerading as evidence, studies with little obvious policy relevance, seemingly endless disputes over the desired outcomes of schooling, low levels of replicability, large error margins, opaqueness of data and sources, unwillingness or inability to agree on a common set of metrics, and the inevitable intrusion of ideology at the ground level.[10]

Recent political developments—in Congress, the administration, and within the major associations that represent professional educational researchers—are also plausible indicators. Indeed, even if current interest in evidence-based policy were no more than a continuation of historical trends, it would be sufficient to warrant a careful systematic analysis.[11] Clearly the emergence of similar concerns in other sectors (e.g., the advent of evidence-based medicine) strengthens the case to revisit fundamental principles of science and their special applications to educational research.

Our final caveat concerns an important and subtle distinction between education scholarship generally and scientific educational research specifically. We focus on the latter. Though we assume unapologetically that scientific research is an endeavor that can uniquely contribute to greater understanding and improvement of education, we do not intend to minimize the significance of humanistic, historic, philosophical, and other nonscientific forms of study in education.[12] Indeed, the NRC report itself rests on a solid base of historical lessons about, and philosophical understanding of, the complexities of the topic.

We do believe, however, that the arguments we make about promoting a scientific culture can be applied to educational scholarship more broadly, in the sense that establishing a stronger sense of community within the scholarly profession would propel the field forward (Shulman, 1999). We therefore use terms like *science, research, scholarship*, and *inquiry* as essentially interchangeable in the specific context of discussing the norms and ideals of the educational research field while recognizing that these words have different meanings generally.

Taking a Step Back: SBR Redux

The current trend of bringing research to bear on education policy and practice has its roots in the broader education reform movement of the last few decades. The advent of standards-based accountability systems in the 1980s created new reasons for decision makers to rely on research. The trend has been steady, beginning with notions of bridging educational research and practice that quietly but steadily crept into federal law through the 1990s. Examples are the Reading Excellence Act of 1988[13] and

the Comprehensive School Reform Demonstration Act of 1997, which were major components of the evolving federal education enterprise and included explicit reference to the use of research-based programs.

As accountability for results became the clarion call in education reform, and as the stakes associated with measurable outcomes were raised quickly and dramatically, new incentives developed for educators to seek guidance from the research community on strategies proven effective in boosting student achievement. The transition was ably summarized by a participant in a workshop on scientific inquiry in education: ". . . Educators have never asked much of educational research and development, and that's exactly what we gave them. That's not true any more" (NRC, 2001).

This linking of standards-based reform (SBR) to scientifically-based research (SBR) has been complicated by the increasingly popular view that other fields already do better at integrating research findings into practice and education needs to catch up. A commonly heard lament is posed as a biting rhetorical question: When will education produce the equivalent of a Salk vaccine? This translates to a denunciation of educational research as being woefully inadequate at treating the fundamental pathologies of our school system, especially as compared to how medical research has informed the science of healing. The fact that "evidence-based medicine" is relatively new (see, e.g., Willinsky, 2001a); the medical community remains divided on the extent to which scientific information can or should drive practice (e.g., "Evidence-based," 2001); even the most sophisticated medical research often results in conflicting or transitory results (e.g., "Circling," 2002); and analogies between education and medicine are limited[14] does not change the underlying reality: Most people consider education behind medicine (and other fields) in the design, execution, and application of high-quality research (Raudenbush, 2002).

The unifying theme of the NRC report is the importance of community and culture within the field.

Against this backdrop, we develop our notion of a scientific culture and its importance in educational research by providing a summary and elaboration of select points within the NRC report. We begin with a brief history of scientific research in education and focus on the ways in which educational research shares fundamental principles with other scientific endeavors. We then argue that though all of science follows a core set of principles, each field—including education—develops its own specific norms and procedures. In this context, we discuss method: why the choice of method must be linked to the question being studied and some methods are better than others for certain types of questions. We briefly discuss the topic of randomized field trials given its current prominence in recent initiatives. Finally, we turn to the institutional question of how a federal educational research agency and AERA can promote a professional research culture, thereby fostering high-quality scientific educational research.

Culture and Community

Throughout its treatment of the history and philosophy of educational research, its depiction of the core nature of scientific inquiry in education, and its proposed framework for a federal educational research agency, the unifying theme of the NRC report is the importance of community and culture within the field. In arguing that it is the self-regulating norms of a community of investigators that propels scientific understanding forward, the committee challenges the field to develop and nurture such a culture. In this section, we elaborate on this theme and make the challenge explicit.

In Search of the Community: History and Philosophy of Science (of Education)[15]

The history of educational research is not a simple tale of progress, and its story provides important insights for its future. Educational research has a long history of struggling to become—or to ward off—science (Lagemann, 2000). It began as a branch of psychology at a time when psychology was still a part of philosophy. Moreover, many of the social and behavioral sciences that form the disciplinary core of educational research themselves have struggled to attain a sense of unity as a community of investigators (Wilson, 1998).

In the first decade of the 20th century, psychology was emerging as a distinct field, as were the budding fields of educational psychology, history of education, and educational administration. By the 1930s, subfields of work that centered on different subjects of the school curriculum—notably reading, mathematics, and social studies—had also emerged. As educational research continued to develop new methods and questions and in response to developments in the social and behavioral sciences, research fields proliferated (Cronbach & Suppes, 1969; Lagemann, 2000).

During this time, the philosophy of the social and behavioral sciences and education was evolving, as were methods and norms of social science research. Significant advances included attention to the complexities of human thought and action (Phillips, 2000; Phillips & Burbules, 2000) and new theories and evidence on rational decision making (e.g., March & Simon, 1958). Further, more sophisticated definitions of *progress* in science and the achievement of it emerged. Linear models of progress were put aside in favor of more jagged ones. Mistakes are made as science moves forward.[16] The process is not infallible (see Lakatos & Musgrave, 1970). Critically, the history of science teaches that there is no algorithm for scientific progress, but rather that science advances through a complex combination of professional criticism and self-correction (e.g., Popper, 1959).

Given the history and epistemological evolution of educational research, the rapid growth of the field, and the sheer complexity of the enterprise, it is hardly surprising that the cadre of researchers

who study education are an eclectic mix of professionals. In the NRC report and this article we point to this fact as evidence of both a strength and a weakness of educational research. However, for the purposes of discussing a research community as the key driver promoting scientific understanding (Kuhn, 1962), it is clear that this diversity has made the development of common ground difficult.

Principles of Scientific Inquiry[17]

In elucidating the nature of scientific inquiry in education, the NRC committee had to grapple with a set of comparative questions: Is educational research different from its cousins in social and behavioral sciences or for that matter different from its more distant relatives in the physical and life sciences? If so, how? Is the so-called medical model appropriate?

The NRC report argues that all the sciences—including the scientific study of education—share a set of epistemological or fundamental guiding principles. Although no universally accepted description of the principles of inquiry exists, we argue nonetheless that all scientific endeavors

- Pose significant questions that can be investigated empirically,
- Link research to relevant theory,
- Use methods that permit direct investigation of the questions,
- Provide a coherent and explicit chain of reasoning,
- Yield findings that replicate and generalize across studies, and
- Disclose research data and methods to enable and encourage professional scrutiny and critique.

These principles need to be understood not as an algorithm, checklist, or how-to guide but rather as norms of behavior that reflect expectations for how scientific research will be conducted. It is very unlikely that any one study would possess all of these qualities although a successful program of research is likely to embody all of them.

Ideally, as in all professional communities, scientific researchers internalize these norms and community members monitor them. In short, the principles define a culture of inquiry. This culture fosters objectivity through enforcement of the rules of its "form of life" (Wittgenstein, 1968)—the need for replicability, the free flow of constructive critique, the desirability of blind refereeing—and concerted efforts to train scientists in certain habits of mind: dedication to the primacy of evidence; to elucidation and reduction of biases that might affect the research process; and to disciplined, creative, and open-minded thinking. These habits, together with the watchfulness of the community as a whole, result in a cadre of investigators who can engage differing perspectives and explanations in their work and consider alternative paradigms. Perhaps above all, communally enforced norms ensure as much as is humanly possible that individual scientists are willing to open their work to criticism, assessment, and potential revision.

What Makes Education Special?[18]

We have proposed here a broad characterization of science and argued that guiding principles apply generically to all scientific endeavors. Does this mean that educational research is the same as astronomy? Or that economics is the same as cell biology? Or that the medical model can be imported wholesale into the study of education? No. The point is that while all science shares a set of underlying principles of inquiry, the ways these norms are instantiated vary in clear and important ways. Each field has features that influence what questions are asked, how research is designed, how it is carried out, and how it is interpreted and generalized.

The NRC committee described several features in education that shape its systematic study: for example, the role of values and democratic ideals in the schools; the volition and diversity of people (teachers, students, administrators); and the variability of curriculum, instruction, and governance across educational settings. The committee argued that these features, while not individually unique among professional and disciplinary fields of study, are singular in their combination and require close attention to powerful contextual factors in the research process. Scholars working in a particular area collectively—as a community—establish the scientific traditions and standards for how to most appropriately apply the guiding principles to their area of study (Diamond, 1999).

The characteristics of the profession of educational research affect the nature of the work as well as conceptions of community. For example, the presence of numerous disciplinary perspectives (e.g., anthropology, psychology, sociology, economics, neuroscience) focusing on different parts of the system means that there are many legitimate research frameworks, methods (Howe & Eisenhart, 1990), and norms of inquiry. But because numerous fields focus on different parts of the system, seemingly contradictory conclusions may be offered, adding fuel to the debates about both the specific topic and the value of the research to aid decision making. The challenge for the field of education is to bring diverse communities—both scientific and otherwise—together to integrate theories and empirical findings across domains, cultures, and methods.

Further, as in other applied fields—such as agriculture, health risk reduction, crime, justice, and welfare—educational research relies critically on relationships between researchers and those engaged in professional practice: teachers, administrators, curriculum developers, university deans, school board members, and a host of others. The educational research enterprise could not function without these relationships, and its vitality depends in part on the willingness of practitioners to participate in, or otherwise support, research.

Method Matters[19]

The NRC report argues that particular designs or methods in a study or program of research do not make them scientific. However, if (educational) research is in line with scientific principles and attends to the relevant contextual features (of education), it could then be considered scientific. Judgments about scientific merit of a particular method can only be accomplished with respect to its ability to address the particular question at hand. To organize its discussion of method around this core principle, the NRC committee used a typology based on the questions commonly framed in educational (and much social science) research: What is happening (description); is there a systematic effect (cause); and why or how is it happening (process or mechanism)? A range of methods can legitimately be employed to address each type of question, and the choice should be governed by the particular purposes and circumstances of the research.

This said, it is also true that some methods are better than others for particular purposes:

> We know that some methods of inquiry are better than others in just the same way in which we know that some methods of surgery, arm-

> ing, road-making, navigating, or what-not are better than others. It does not follow in any of these cases that the "better" methods are ideally perfect. . . . We ascertain how and why certain means and agencies have provided warrantably assertible conclusions, while others have not and cannot do so. (Dewey, 1938, p. 104)

In approaching the highly contested terrain of method in educational research, the NRC report makes two major points for our purposes. First, it dispels the myth that science is synonymous with a particular method. Although method is key to science, method does not uniquely define science and choices of method are often highly nuanced. Second, specifically with respect to developing a common research culture, the report implicitly cautions researchers against organizing themselves exclusively according to common methods. The question drives the methods, not the other way around. The overzealous adherence to the use of any given research design flies in the face of this fundamental principle.

For example, when well-specified causal hypotheses can be formulated and randomization to treatment and control conditions is ethical and feasible, a randomized experiment is the best method for estimating effects.[20] Due to its prominence in recent policy initiatives and its history of controversy, this point is worth brief elaboration. Although we strongly oppose blunt federal mandates that reduce scientific inquiry to one method applied inappropriately to every type of research question, we also believe that the field should use this tool in studies in education more often than is current practice. Randomly assigning units of analysis to various conditions in education is not always feasible. Studying the impact of teacher salary on student drop out rates, for example, does not easily lend itself to this design: randomly assigning teachers to different salaries, though scientifically attractive, will most likely be practically infeasible (see Loeb & Page, 2000).[21] In other cases, the external validity of a randomized field trial may be low relative to other designs (Cronbach, 1982). And perhaps most important from a practical standpoint is the high cost of implementing these designs effectively, which should always be weighed against the potential benefits as measured by improved understanding and validity of results. The bottom line is that experimentation has been shown to be feasible in education and related fields (e.g., Bogatz & Ball, 1972; Fuchs, Fuchs, & Kazdan, 1999; see also Boruch, DeMoya, & Snyder, in press; Orr, 1999; Murray, 1998) and is still the single best methodological route to ferreting out systematic relations between actions and outcomes.

We make these claims recognizing that the language associated with this method and its application has often contributed to a narrow view of science (both inside and outside education). Indeed, although not always explicit, the rhetoric of scientifically based research in education seems to denigrate the legitimate role of qualitative methods in elucidating the complexities of teaching, learning, and schooling. When a problem is poorly understood and plausible hypotheses are scant—as is the case in many areas of education—qualitative methods such as ethnographies (Agar, 1996) and other tools like design experiments (Brown, 1992) are necessary to describe complex phenomena, generate theoretical models, and reframe questions.

In keeping with our claim of the importance of attending to context in all scientific studies of education, we believe that understanding causal processes and mechanisms requires close attention to contextual factors and that capturing these complexities typically involves qualitative modes of inquiry. Indeed, clarifying the conditions and contexts that shape causal connections in social and behavioral queries is essential for the progression of science and for its use in informing public policy. Specifically, generalizing findings and thus enriching our understanding of the applicability of a particular educational strategy across diverse settings and peoples that characterize education are issues of highest concern to those championing evidence-based education.

We want to be explicit, then, that we do not view our strong support for more randomized field trials and our equally strong argument for close attention to context in the research process as incompatible. Quite the contrary: When properly applied, quantitative and qualitative research tools can both be employed rigorously and together often can support stronger scientific inferences than when either is employed in isolation. Again, the key to progress lies in the capacity and willingness of investigators from these different perspectives to constructively engage each other's differing perspectives around the common goal of advancing understanding.

Finally, although we have focused on causal studies of education programs to illustrate our point that method is driven by the particularities of the research question, we reiterate that such queries do not constitute the whole of educational research. Nor do such studies constitute the whole of educational research that can inform school improvement, although the current policy focus is unmistakably on establishing programmatic effects. Fundamental studies of cognitive processes, ethnographic studies of cultural influences on schools and schooling, and rich descriptions of the nature of educational change in school systems are but a few such examples (see the NRC report for an array of examples that more fully depicts this range). Our point here is not to debate the relative merits of methods. No method is good, bad, scientific, or unscientific in itself: Rather, it is the appropriate application of method to a particular problem that enables judgments about scientific quality.

Again, Culture and Community

In this selected summary of the NRC report, we reinforce the committee's depiction of a community of investigators with a strong scientific culture as the key to a healthy research enterprise. This emphasis places the challenge of improving the reputation of the profession squarely in the hands of the researchers themselves. Why do lawmakers feel compelled to codify methods of educational research in federal statute? Perhaps it is because they do not trust the field to monitor itself. Indeed, one wonders if policymakers would direct epidemiologists on such matters in the authorizing statute for the National Institutes of Health (NIH), for example. To be sure, the tension between science and politics we have described is evident in every field. However, the tension in the case of educational research reflects a crisis of confidence during a particularly important time in its history that must be addressed if the field is to take full advantage of the present opportunity.

In crude terms, a culture typically grows naturally within a fairly homogeneous group with shared values, goals, and customs. Yet as we have described, researchers in education are quite

heterogeneous, engaging in their craft from different disciplinary backgrounds, viewing the enterprise through divergent epistemological lenses, employing various methods, and even holding competing objectives. The NRC committee argued not only that this diversity of perspectives is predictable given the nature of education, but that it lends the field intellectual vitality. However, it is also not surprising that it has been difficult to cultivate and build on existing consensus to develop a public character of self-regulation and communal progress.

The notion of culture, however, has evolved beyond earlier conceptions that emphasized the universal sharing of ideas. Indeed, modern anthropologists typically view cultures as typified by a good degree of internal diversity (Hannerz, 1992). Similarly, the cultural norms and ideals of a professional research community we describe here as the driver of scientific advancement do not necessitate or encourage the standardization of thought. Such a scenario would be anathema to scientific innovation and would connote an oversimplified conception of education. Indeed, we must dispense with the myth that any scientific community will be of one mind at any given point in time or, related, that there is a simple panacea for the ills of schools just waiting to be discovered by educational researchers.

These acknowledgments notwithstanding, we stand by our call to the research community to focus on what unites rather than on what divides. It is vital to encourage stronger collective attention to ensuring rigor and objectivity and promoting consensus building, particularly at this unprecedented historical moment. Taking proactive steps to cultivate a "community of practice" (Wenger, 1998) in the profession can focus needed attention on guarding "against the dangers of compartmentalization . . ." and developing " . . . a sense of the big picture and how things fit together" (Schoenfeld, 1999, p. 170). It is in this sense that we argue for understanding and appreciating the multiple perspectives in education in the service of developing a strong, self-regulating culture. And we believe that a key part of this multifaceted task must include a focus on developing rigorous norms that ensure scientific principles are properly applied to the educational problems and questions that are the grist for the educational researcher's mill. In short, researchers must have a clear, commonly held understanding of how scientific claims are warranted.

We believe it is the failure of the field to develop such a community and to forge consensus on such matters as research quality and coordination of perspectives that has contributed to an environment in which members of Congress are compelled to impose them. And we are certainly not the first to suggest that attention to building a community is an essential task of the future for educational researchers (see, e.g., Pallas, 2001; Shulman, 1999). In stark terms, we believe that if the field is to argue convincingly that it is inappropriate for science to be defined by political forces—which we believe is true—then it is incumbent upon the field to cultivate its own form of life including, however difficult this may be, attention to bolstering research quality.

We do not purport to offer a comprehensive strategy for charting the course of the future. The talent pool in educational research is shaped by a number of structural, historical, and cultural factors, and the field is characterized by deep epistemological and methodological complexities. We also acknowledge that self-regulating norms in other scientific disciplines are, in many instances, implicit rather than codified: that is, it is not necessarily the case that scientific societies have written enforceable rules for their own members, though the successful scientific disciplines do tend to operate at least to an extent as if such rules existed. For example, educational research would be naïve if it did not allow for multiple outcomes to be explored and measured: The historical, cultural, political, and ideological influences on education policy and hence on educational research are real and inescapable. At the same time, this proliferation of outcome measures presents a formidable obstacle to replicability, the accumulation of enduring knowledge, and the capacity to achieve consensus. We have tried, however, to provide a compelling justification that given the current policy environment and the importance of a cohesive community in scholarly endeavors generally, grass-roots action is warranted. And we do suggest that central institutions like a federal educational research agency and AERA must lead the way.

Institutional Leadership

A Federal Educational Research Agency[22]

The NRC committee did not join the debate about the future of OERI by taking on the specific battles of the day (e.g., should OERI be organizationally separate from the U.S. Department of Education? Should evaluation of federal programs be placed under OERI?). Rather, it offered a set of design principles for a federal educational research agency with the overarching goal, again, of developing a scientific culture that promotes rigorous scientific research. The premise is that just as the scientific enterprise is supported through the norms of the research community, cultivating these values within a research agency is a key to its success.

Human resources. A scientific culture begins and ends with people. Attracting and retaining qualified leaders, staff, board members, and peer reviewers is therefore critical to a healthy federal educational research agency. Unfortunately, however, the current federal educational research agency, OERI, suffers from a poor reputation, and meager resources have resulted in drastic reductions in staff in the last few decades (Vinovskis, 2001). No quick policy fix will improve the situation. Federal educational research agency leaders will need to work hard to make federal service attractive; this would likely involve a mix of strategies to improve its reputation and to develop a staff that includes both core permanent staff and short-term visiting scholars. Providing ongoing professional development opportunities for research staff will also be critical to allow continuing and sustained interaction with the broader research communities. Still another way for a federal educational research agency to cultivate scientific norms and practices in its staff is to engage in collaborative research efforts with other agencies to encourage interdisciplinary interaction and learning. Above all, agency leadership and staff must themselves be highly respected researchers who espouse and understand scientific norms, especially with respect to issues of research quality. Adequate funding is of course a critical issue in itself,[23] but it is also related to the ability to staff the agency with high caliber researchers. Increasing funding levels will make educational research generally and federal service specifically more attractive professional options.

Ultimately, the responsibility to engage topflight researchers in the work of the agency in the short term and to enhance the profession in the long term does not rest solely with the federal government. It is the professional responsibility of researchers to participate in efforts that promote scientific collaboration, consultation, and critique, and a federal agency is a natural place to engage in that work. The future of the field—and the federal agency that supports it—will depend in no small part on finding new ways to harness the scholarly potential of its diverse perspectives. Formal peer review is potentially a critically important mechanism in this regard.

Self-regulation and focus. Peer review is the single most commonly used mechanism for nurturing a scientific culture within and outside federal research agencies and should play a central role in a federal educational research agency. Ideally, peer review is both a process by which scientific work is assessed and funded and a product that provides a venue for the scientific culture of self-regulation (Chubin & Hackett, 1990). Peer review can be successfully employed as a feedback mechanism for the field (NRC, 2001). The review process encourages the development of an active community of scientists working together on education problems: The process of reviewing proposals and communicating feedback fosters the development of common standards of quality and other scientific norms in the field over time.

The process of peer review, then, is an essential mechanism for fostering a common culture among the diverse group of researchers who study education. If standing review panels (akin to NIH study sections) are used as primary peer review vehicles, researchers can provide continuity in overseeing research programs that focus the resources of the agency on solving core problems in education. This suggestion reinforces the recommendations of several other groups to target federal educational research resources in this way, including the RAND panels (see http://www.rand.org/multi/achievementforall/), the NERPPB (2000) in its policy statements, and the NRC's Strategic Educational Research Partnership (1999).

Such programs would focus the diverse strengths of the field on common problems and provide a framework for the development of regular syntheses of related work. Although the NRC report points to several successful lines of work that have generated cumulative knowledge over a sustained period, it also argues that more such focused inquiry is needed. Taking stock of the state of current knowledge on a regular basis is a key part of the culture of inquiry that enables scientific consensus, extends the boundaries of what is known, identifies knowledge gaps, and lays the groundwork for future investigation.

A final word on peer review: Although we strongly believe in its merits as a mechanism for developing the community character of scientific educational research, it is not perfect. It can stifle innovation (Cicchetti, 1991), and its successful implementation will require diligence and care with respect to the composition of review panels. The key to peer review, of course, is competent peers, and understanding what *competent* means in scientific educational research is complex given the diversity associated with the field.

Political insulation: A porous buffer. A federal educational research agency must be designed to prevent inappropriate political criteria from entering into the agency's agenda for research, its choice of research studies, its selection of grantees, and its scientific norms. Ensuring that political interference is minimal will help foster a scientific culture, protect the scientific process, and prevent research from being sacrificed to the policy passions and practice fads of the day. However, it is unrealistic and undesirable to buffer the agency from politics completely. It would be simply incompatible with the American tradition of democratic governance to exclude political and social influences from decisions about research priorities or to assume that the research community (unlike any other sector in U.S. society) deserves complete immunity from external accountability. Although research should not be driven only by the needs of the moment, proper attention must be paid to concerns of the general public and the nation's leaders.

Another reason to allow for what we call a "porous buffer" is more practical: For the research community to gain the respect and credibility it needs to ensure continuous financial and intellectual support and promote better research, stewards of the enterprise need to maintain healthy and collegial relations with the potential "consumers" of their work both in and out of government. To do so requires more sustained interaction between researchers and other education stakeholders than is currently typical.[24]

Infrastructure: People and processes. To promote high-quality educational research, a federal educational research agency must also invest part of its annual appropriations in research infrastructure. Simply funding more studies will not be enough to foster the development of the field in the long term. Importantly, the federal government is uniquely positioned to make substantial funding available for promoting the long-term capacity of the research community. The NRC committee specifically recommended investment in three connected pillars of the scientific research infrastructure: the research community; data development, information sharing, and access; and links to practice and policy communities. We elaborate on the first two as they relate to developing a scientific culture.

A federal agency must play a role in nurturing the community of educational researchers. The greater the field's ability to conduct high-quality scientific research in education and to monitor and maintain high scientific standards, the greater is the likelihood the agency will succeed in its mission. Further, a federal agency can leverage its investment in human resources through partnerships with other federal agencies, scholarly professional associations, colleges and universities (especially schools of education), journal publishers, and others. These partnerships could lay the foundation for broad-based efforts aimed at various parts of the system that interact with the educational research profession. For example, partnerships with journal publishers and professional associations could lead to the development and monitoring of guidelines or standards for journal publications and professional meetings. Collaborations with professional associations might feature training and fellowship programs for young scholars, such as the AERA Institute on Statistical Analysis for Education Policy (http://www.aera.net/grantsprogram/subweb/SIFly-FR.html) at AERA annual meetings, part of the AERA Research Grants Program (Shavelson, 1991).[25] The agency could also forge links with schools of education, schools of arts and sciences, and other uni-

versity departments to develop strategies for training and supporting future scientists in educational research.

Investing in the community is a long-term undertaking. Current scholarship in education is generated by investigators trained in schools of education as well as in, for example, psychology, history, economics, sociology, mathematics, biology, and public policy departments. In schools of education, students often pursue non-research-oriented goals (e.g., school administration) and may therefore reach the graduate level without research training. Beyond graduate training of educational researchers, publication standards and peer review also vary considerably in education journals as in other fields. These complex structural issues will require careful study and innovative approaches to address them effectively. These efforts on the part of a federal agency cannot be accomplished without the active cooperation of individual investigators in pursing these common goals.

Investing in data development, promoting secondary data analysis, and fostering ethical access to research participants is another key infrastructure investment of a federal educational research agency. Data derived from multiple methods (e.g., surveys, videos) and stored centrally can facilitate professional communication and collaboration and in particular attempts at replication—a fundamental principle of all scientific endeavors. The development of common constructs can also contribute to a cohesive knowledge core and further enhance theoretical understanding. Related, technological advances such as listservs, bulletin boards, and rising capacities for database storage and analysis offer rich resources for the research community and the potential to advance the field in turn (Pea, 1999).

This is a unique time of possibility—and peril—for the field.

The American Educational Research Association

To its credit, AERA, an international professional organization with the primary goal of advancing educational research and its application, has taken important steps to improve the educational research infrastructure in recent years (often, it should be noted, in collaboration with OERI). For example, a Research Advisory Committee focuses on issues related to research quality, the preparation of new researchers, and funding. (See http://www.aera.net/about/whoswho/radcomm.htm).

Moreover, AERA sponsors research-training programs at its annual meeting and at other times during the year. For example, for the past 11 years, the AERA Research Grants Program (http://www.aera.net/grantsprogram), sponsored by National Center for Education Statistics (NCES), National Science Foundation (NSF), and OERI, has had the goals of stimulating quantitative policy and practice related research on U.S. education using large-scale, nationally representative NCES and NSF data sets; encouraging and training in the use of these data sets; and placing scholars at NCES and NSF to learn about the education policy environment and to serve as resident resources while conducting independent research. And the new AERA/OERI Grants Program's goals are stimulating research on fundamental educational issues (with a priority for the education of poor, urban, or minority students and for mathematics and literacy education); attracting a cadre of talented scholars and enhancing their research preparation; building a network of scholars whose collaborations focus on high priority educational issues; and contributing to basic knowledge, policy, and the improvement of practice in educationally important contexts (http://www.aera.net/anews/announce/af01-002.htm). We commend AERA for these initiatives but suspect that only a small fraction of its more than 20,000 members are aware of—let alone influenced by—these efforts. To borrow from a phrase made famous in corporate America, quality is still "Job 1," and AERA needs to be empowered by its members to do what it can to maintain and nurture its continuous improvement.

Tough questions for AERA, a federal educational research agency, and the field to address include the following: What are the key experiences and practices that should form the core of a scientific community and culture? In particular, what are the possibilities and barriers to forging consensus about what constitutes quality in scientific and other educational research? How can conceptual understandings based on warranted knowledge be accumulated? How can AERA researchers capitalize on the strengths that emanate from a diversity of perspectives? What are the implications for research training and professional development, both inside and outside schools of education? Will educational research need to be parsed into smaller subgroups or coalesced into larger groups—some of which exist to some degree already (e.g., mathematics education; see Romberg, 2001)—to maximize commonalities and thus the likelihood of consensus and progress? What are the responsibilities, if any, of the field to monitor research quality as well as to engage other education stakeholders in its work?

We Have Seen the Enemy . . .

This article has, perhaps presumptuously, focused on the nature of the educational research craft and the responsibilities of participating in a culture of inquiry and likely raised more questions than provided answers. We have emphasized that generic principles apply to all scientific endeavors but argued how those principles can and should be customized to the multiple contexts in which education takes place. We have opined that method is a function of purpose and cautioned against the overzealous adherence to any single research design. We have also unapologetically supported scientific educational research without retreating from the view that the ecology of educational research is as complex as the field it studies and that education scholarship therefore must embody more than scientific studies.

This is a unique time of possibility—and peril—for the field. We accept the diagnosis that a self-regulating professional community does not exist in education (Lagemann, 2000), but we believe the future holds great promise. The potential exists for developing a stronger sense of community among educational researchers. The current demand for scientific understanding of

educational phenomena is unmatched in history. Now is the time for the field to move beyond particularized views and focus on building a shared core of norms and practices that emphasize scientific principles. We also encourage the field, and especially AERA, to engage in studies similar to that conducted by the NRC (2002) into the warrants for other forms of educational research. We hope that this article and the NRC report will provide a springboard for meeting the challenge.

NOTES

This article draws heavily from the recent report of the NRC Committee on Scientific Principles in Education Research for which Shavelson was the Chair and Towne the Study Director. We would like to thank committee members Margaret Eisenhart, Norman Hackerman, and Robert Hauser and three anonymous reviewers who provided very helpful comments on a draft. However, the analysis and opinions in this article are solely those of the authors and do not necessarily represent the positions of the National Research Council, the National Academies, or the Committee.

[1] See http://www.edweek.org/ew/newstory.cfm?slug=20whatworks.h21 for a story in *Education Week* (Olson & Viadero, 2002) that describes this legislative change and chronicles initial reactions from prominent researchers in the field.

[2] At least rhetorically. We note, however, that at the time we submitted this article as a manuscript, pending appropriations requests and funding authority for the OERI would provide substantial increases for educational research funding.

[3] We acknowledge that some do not believe the policy is well intended. We take the policy at face value.

[4] Throughout this article, we refer to the need to attend to research quality. We occasionally use the word *standards* in this context, but we recognize that this term may connote too small a "grain size" to be workable. Specifically, we recognize that detailed prescriptions are unworkable in educational research or any other research endeavor.

[5] The National Academies comprises the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. NRC is the operating arm of the Academies, a scientific organization chartered in 1863 to provide independent advice to the government. See http://www.nas.edu/about/faq1.html for a description of the organization and Alberts and Feuer (in press) for a brief history.

[6] We are immensely grateful to each and every one of the members of the committee. In addition to Shavelson as the chair, the committee members were Donald Barfield, Robert Boruch, Jere Confrey, Rudolph Crew, Robert DeHaan, Margaret Eisenhart, Jack Fletcher, Eugene Garcia, Norman Hackerman, Eric Hanushek, Robert Hauser, Paul Holland, Ellen Condliffe Lagemann, Denis Phillips, and Carol Weiss.

[7] This is a recurrent interest among some philosophers and policy analysts who specialize in science and society. See, for example, Kitcher's (2001) and Strawson's (2002) reviews of this work.

[8] To render such sweeping judgments would require consensus on a set of evaluative criteria and review of a massive body of published and fugitive literature—neither of which were in the scope of the committee's charge.

[9] There is an exquisite irony in the way lawmakers and many education leaders seem to want more reliance on research even as they denigrate its quality and rigor. Heralding its promise in one breath, policymakers disparage its quality in the next. As one of the champions of an improved federal presence in educational research put it, "Education research is broken in our country . . . and Congress must work to make it more useful. . . . Research needs to be conducted on a more scientific basis. Educators and policymakers need objective, reliable research. . . ." (Michael Castle (R-DE), as quoted in Viadero, 2000).

[10] We borrow Joseph Schumpeter's lament about the role of ideology in economic doctrine: "ideology enters on the very ground floor, into the pre-analytical cognitive act. . . ." See his *History of Economic Analysis* (1954); also Dobb (1973).

[11] See, for example, Lagemann (2000) for the history of efforts to strengthen the science base for educational research.

[12] We recognize that some forms of these fields are scientific (e.g., historical science) and that, more broadly, science does not neatly map onto disciplines or fields.

[13] The Reading Excellence Act was replaced by the Reading First Initiative, fully implemented in HR1. This initiative retains the emphasis on SBR.

[14] Specifically, many have argued—and we agree—that the complexities of education are not analogous to the physiology of disease and thus the expectation that any single intervention could adequately "cure" an educational "ill" is misplaced. We include the reference here as an illustration of public perceptions and policy rhetoric; we do not intend to take on the underlying substantive issues. For particularly important insights to this and related questions, see, for example, Nelson (1977) and Murnane and Nelson (1984). For the strongest argument in favor of adoption of the randomized clinical trial in education research, see Cook (2002).

[15] This section draws mostly from NRC (2002), chapter 1.

[16] This is also true of the physical and natural sciences. See Stranges (1982) for a fascinating historical example of this complex progression of science in developing the electron theory of valence.

[17] This section draws mostly from NRC (2002), chapter 3.

[18] This section draws mostly from NRC (2002), chapter 4.

[19] This section draws mostly from NRC (2002), chapter 5.

[20] We recognize that many who espouse the "realist" view of causation reject randomized field trials as legitimate tools to address causal claims in social queries (see, e.g., Pawson & Tilley, 1997). Although we, and the NRC committee, share some of the ideas that underlie this model (e.g., attention to context and mechanism), we do not believe that these arguments provide a basis to reject experiments and indeed maintain our strong support for them as appropriate and powerful methods in establishing causal effects.

[21] Researchers in a range of fields have successfully employed random assignment models in similar situations (e.g., experiments charting the behavioral consequences of randomly determined variations in family income). Such innovations can increase the likelihood that these methods can be used in practice but do not eliminate completely the practical limits on their feasibility.

[22] This section draws mostly from NRC (2002), chapter 6.

[23] The NRC committee concurs with those who have argued that the enterprise has been significantly hamstrung by a lack of resources (NRC, 1999, 2001; President's Committee of Advisers on Science and Technology, 1997; Shavelson & Berliner, 1988; Vinovskis, 2000). Funding has not been aligned historically with the intended scope of the educational research enterprise, and the current breadth of the educational research agenda warrants sustained increases into the future if it is to meet its mandate. But increased funding without attention to fundamental design issues—as described in the NRC report—will be inadequate to elevate and sustain quality in federally funded scientific educational research.

[24] The NRC's Strategic Education Research Partnership aims to develop the capacity and infrastructure for such collaboration. See NRC (1999) and Willinsky (2001b). Indeed, on the subtle problems of maintaining independence while nurturing healthy interaction with government sponsors, the 138-year experience of the National Academies could be instructive.

[25] The AERA Grants Program is jointly funded by National Center for Education Statistics (NCES), National Science Foundation (NSF),

and OERI. In addition to an annual statistics institute, the program supports dissertation and field-initiated research studies and research fellows at NSF (Leigh Burstein Research Fellows) and NCES (Jeanne Griffith Research Fellows).

REFERENCES

Agar, M. (1996). *The professional stranger: An informal introduction to ethnography.* San Diego, CA: Academic Press.

Alberts, B., & Feuer, M. (in press). The National Academies. In *Encyclopedia of education* (2nd ed.). New York: Macmillan.

Bogatz, G. A., & Ball, S. (1972). *The impact of Sesame Street on children's first school experiences.* Princeton, NJ: Educational Testing Service.

Boruch, R. F., DeMoya, D., & Snyder, B. (in press). The importance of randomized field trials in education and related areas. In F. Mosteller & R. Boruch (Eds.), *Evidence matters: Randomized trials in educational research.* Washington, DC: Brookings Institution Press.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences, 2,* 141–178.

Chubin, D. E., & Hackett, E. J. (1990). *Peerless science: Peer review and U.S. science policy.* Albany, NY: State University of New York Press.

Cicchetti, D. V. (1991). The reliability of peer review for manuscript and grant submissions: A cross-disciplinary investigation. *Behavioral and Brain Sciences, 14*(1), 119–135.

Circling the mammography wagons. (2002, February 6). *The New York Times*, p. A20.

Cook, T. D. (2002, February). *The three cultures of research on effective practices in schools: Given their diversity, what can (and should) the Campbell Collaboration do?* Paper presented at the Campbell Collaboration Colloquium, Philadelphia, PA.

Cronbach, L. J. (with Shapiro, K.). (1982). *Designing evaluations of educational and social programs.* San Francisco: Jossey-Bass.

Cronbach, L. J., Ambron, S. R., Dornbusch, S. M., Hess, R. D., Hornik, R. C., Phillips, D. C., et al. (1980). *Toward reform of program evaluation.* San Francisco: Jossey Bass.

Cronbach, L. J., & Suppes, P. (Eds.). (1969). *Research for tomorrow's schools.* New York: Macmillan.

Dewey, J. (1938). *Logic: The theory of inquiry.* New York: H. Holt and Company.

Diamond, J. (1999). *Guns, germs, and steel.* New York: Norton.

Dobb, M. H. (1973). *Theories of value and distribution since Adam Smith: Ideology and economic theory.* Cambridge, UK: Cambridge University Press.

Evidence-based medicine in respiratory care: Parts I & II [Special issues]. (2001). *Respiratory Care, 46*(12 & 13).

Fuchs, L. S., Fuchs, D., & Kazdan, S. (1999). Effects of peer-assisted learning strategies on high school students with serious reading problems. *Remedial & Special Education, 20*(5), 309–318.

Guba, E. G., & Lincoln, Y. S. (1981). *Effective evaluation.* San Francisco: Jossey-Bass.

Hannerz, U. (1992). *Cultural complexity: Studies in the social organization of meaning.* New York: Columbia University Press.

Howe, K., & Eisenhart, M. (1990). Standards for qualitative (and quantitative) research: A prolegomenon. *Educational Researcher, 19*(4), 2–9.

Kaestle, C. F. (1993). The awful reputation of educational research. *Educational Researcher, 22*(1), 26–31.

Kitcher, P. (2001). *Science, truth, and democracy.* New York: Oxford University Press.

Kuhn, T. S. (1962). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Lagemann, E. C. (2000). *An elusive science: The troubling history of educational research.* Chicago: University of Chicago Press.

Lakatos, I., & Musgrave, A. (Eds.). (1970). *Criticism and the growth of knowledge.* Cambridge, UK: Cambridge University Press.

Loeb, S., & Page, M. E. (2000). Examining the link between teacher wages and student outcomes: The importance of alternative labor market opportunities and non-pecuniary variation. *Review of Economics & Statistics 82*(3), 393–408.

March, J. G., & Simon, H. A. (with Guetzkow, H.). (1958). *Organizations.* New York: Wiley.

Murnane, R. J., & Nelson, R. (1984). Production and innovation when techniques are tacit: The case of education. *Journal of Economic Behavior and Organizations,* 5, 353–373.

Murray, D. M. (1998). *Design and analysis of group randomized trials.* New York: Oxford University Press.

National Educational Research Policy and Priorities Board, U.S. Department of Education. (2000). *Investing in learning: A policy statement with recommendations on research in education. Investing in research: A second policy statement with further recommendations for research in education.* Washington, DC: Author.

National Research Council. (1958). *A proposed organization for research in education.* Washington, DC: National Academy of Sciences.

National Research Council. (1977). *Fundamental research and the process of education.* S. B. Kiesler & C. F. Turner (Eds.), Committee on Fundamental Research Relevant to Education. Washington, DC: National Academy of Sciences.

National Research Council. (1992). *Research and education reform: Roles for the Office of Educational Research and Improvement.* R. C. Atkinson & G. B. Jackson (Eds.), Committee on the Federal Role in Educational Research. Washington, DC: National Academy Press.

National Research Council. (1999). *Improving student learning: A strategic plan for educational research and its utilization.* Committee on a Feasibility Study for a Strategic Education Research Program. Washington, DC: National Academy Press.

National Research Council. (2001). *Science, evidence, and inference in education: Report of a workshop.* L. Towne, R. J. Shavelson, & M. J. Feuer (Eds), Committee on Scientific Principles in Education Research. Washington, DC: National Academy Press.

National Research Council. (2002). *Scientific research in education.* R. J. Shavelson & L. Towne (Eds.), Committee on Scientific Principles for Educational Research. Washington, DC: National Academy Press.

Nelson, R. R. (1977). *The moon and the ghetto.* New York: Norton.

No Child Left Behind Act of 2001, Pub. L. No. 107–110.

Olson, O., & Viadero, D. (2002, January 30). Law mandates scientific base for research. *Education Week,* pp. 1, 14, 15.

Orr, L. L. (1999). *Social experiments: Evaluating public programs with experimental methods.* Thousand Oaks, CA: Sage.

Pallas, A. M. (2001). Preparing education doctoral students for epistemological diversity. *Educational Researcher, 30*(5), 6–11.

Pawson, R., & Tilley, N. (1997). *Realistic evaluation.* Thousand Oaks, CA: Sage.

Pea, R. D. (1999). New media communication forums for improving educational research and practice. In E. C. Lagemann & L. S. Shulman (Eds.), *Issues in educational research: Problems and possibilities* (pp. 336–370). San Francisco: Jossey Bass.

Phillips, D. (2000). *The expanded social scientist's bestiary: A guide to fabled threats to, and defenses of, naturalistic social science.* Lanham, MD: Rowman & Littlefield.

Phillips, D., & Burbules, N. C. (2000). *Postpositivism and educational research.* Lanham, MD: Rowman & Littlefield Publishers.

Popper, K. R. (1959). *The logic of scientific discovery.* New York: Basic Books.

President's Committee of Advisors on Science and Technology. (1997). *Report to the president on the use of technology to strengthen K–12 education in the United States.* Retrieved August 21, 2001, from http://www.ostp.gov/PCAST/k-12ed.html.

Raudenbush, S. (2002, February). *Identifying scientifically-based research: What to look for.* Paper presented at the conference of the U.S. Department of Education, Office of Elementary and Secondary Education, titled, "A Scientifically Based Research Seminar," Washington, DC.

Romberg, T. A. (2001). *Creating a research community in mathematics education.* Paper presented at the Spencer Foundation 30th Anniversary Conference, Chicago.

Schoenfeld, A. H. (1999). The core, the canon, and the development of research skills: Issues in the preparation of educational researchers. In E. C. Lagemann & L. S. Shulman (Eds.), *Issues in educational research: Problems and possibilities* (pp. 166–202). San Francisco: Jossey-Bass.

Schumpeter, J. (1954). *History of economic analysis.* New York: Oxford University Press.

Shavelson, R. J. (1991). AERA's research and training grant. *Educational Researcher, 20*(9), 19–20.

Shavelson, R. J., & Berliner, D. C. (1988). Erosion of the educational research infrastructure. *Educational Researcher, 17*(1), 9–12.

Shulman, L. S. (1999). Professing educational scholarship. In E. C. Lagemann & L. S. Shulman (Eds.), *Issues in educational research: Problems and possibilities* (pp. 159–165). San Francisco: Jossey-Bass.

Stranges, A. N. (1982). *Electrons and valence.* College Station, TX: Texas A&M University Press.

Strawson, G. (2002, January 20). Improving scientific ethics through democratization. *The New York Times Book Reviews,* p. 12.

Viadero, D. (2000, August 2). House plan would create research 'academy.' *Education Week,* p. 30.

Vinovskis, M. A. (2000). The federal role in educational research and development. In D. Ravitch (Ed.), *Brookings papers on education policy.* Washington, DC: Brookings Institution.

Vinovskis, M. A. (2001). *Revitalizing federal educational research and development: Improving the R&D centers, regional educational laboratories, and the "new" OERI.* Ann Arbor, MI: The University of Michigan Press.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* Cambridge, UK: Cambridge University Press.

Willinsky, J. (2001a). Extending the prospectus of evidence-based education. *Insight, 1*(1).

Willinsky, J. (2001b). The strategic educational research program and the public value of research. *Educational Researcher, 30*(1), 5–14.

Wilson, E. O. (1998). *Consilience.* New York: Vintage Books.

Wittgenstein, L. (1968). *Philosophical investigations* (3rd ed., G. E. M. Ansombe, Trans.). New York: Macmillan.

AUTHORS

MICHAEL J. FEUER is Executive Director of the Division of Behavioral and Social Sciences and Education at the National Research Council of the National Academies, 500 5th Street, NW, Washington, DC 20001; mfeuer@nas.edu. His research interests include public policy, social science theory and practice, and education.

LISA TOWNE is a senior program officer in the Center for Education of the National Research Council, 500 5th Street, NW, Washington, DC 20001; ltowne@nas.edu. Her research interests include the conduct, use, and infrastructure of educational research.

RICHARD J. SHAVELSON is a professor at Stanford University, School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096; richs@stanford.edu. His research interests include social science research methods and science teaching, learning, and assessment.

Manuscript received February 27, 2002
Revisions received April 16, 2002
Accepted April 17, 2002