Reporting Research for Practitioners: Proposed Guidelines

NCTM Research Committee

Daniel J. Heck
Horizon Research, Inc.

Robert Q. Berry III
University of Virginia

James E. Tarr
University of Missouri

Patricia C. Baltzley
Baltimore County Public Schools

Karen F. Hollebrands
North Carolina State University

Chris L. Rasmussen
San Diego State University

Erica N. Walker
Teachers College, Columbia University

Karen D. King
National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics (NCTM) espouses priorities to foster stronger linkages between mathematics education research and teaching practice. Of the five foundational priorities, one is directly focused on research, indicating NCTM's commitment to "ensure that sound research is integrated into all activities of the Council" (NCTM, n.d.). Another priority specifically references the relationship between research and mathematics teaching; the priority on curriculum, instruction, and assessment states that NCTM pledges to "Provide guidance and resources for developing and implementing mathematics curriculum, instruction, and assessment that are coherent, focused, well-articulated, and *consistent with research in the field* [emphasis added], and focused on increasing student learning" (NCTM, n.d.).

The NCTM Research Committee developed this article to address a distinctly important activity that links research and practice: writing research-based articles for practitioner journals. We offer six principles to guide this work.

NCTM's broad-based membership—numbering over 80,000 pre-K–12 and postsecondary mathematics teachers, mathematics education researchers, mathematics teacher educators, and others—and affiliate organizations serving widely varying constituencies make the importance of tying research and teaching closely together in its foundational priorities especially appropriate. To serve its membership, NCTM publishes journals, series, books, and other products that reflect the Council's constituencies in mathematics teaching, mathematics curriculum, mathematics teacher education, and mathematics education research. The NCTM

Annual Meeting and Exposition, NCTM Research Presession, and the National Council of Supervisors of Mathematics Annual Meeting offer venues for those whose primary role is teaching, research, and leadership, respectively, to present their work and learn about the work of others. These three conferences are held in the same location during the same week, with particular sessions designed to appeal to attendees of all three meetings to foster communication and linkages among those engaged in complementary pursuits in mathematics education.

This intersection of research and practice evident in the membership, publications, and activities of NCTM and its affiliate organizations undergirds the Council's current emphasis on linking research and practice. This emphasis is most appropriately considered and realized not simply as strengthening communication among different constituencies within NCTM's membership but rather as a principle that binds the membership together within a single profession of mathematics education.

Linking Research and Practice: The NCTM Research Agenda Conference Report (Arbaugh, et al., 2010) described actions and commitments that can guide the mathematics education profession through synergies of research and practice. Arising from the work of a broadly representative group of practitioners and researchers, the report presented research-guiding questions of importance to practitioner communities and strategic priorities for the mathematics education research community. Connections between research and practice in mathematics education mirror similar commitments in related fields. For example, the learning sciences have a history of, and strong commitment to, design-based research aimed at linking research and practice. More broadly in education, the U.S. Department of Education's Institute of Education Sciences publishes practice guides "to bring the best available evidence and expertise to bear on the types of challenges that cannot currently be addressed by single interventions or programs" (Tierney, Bailey, Constantine, Finkelstein, & Hurd, 2009, unnumbered overview page).

Stemming from the work of the Linking Research and Practice Task Force (National Council of Teachers of Mathematics Linking Research and Practice Task Force, 2005), NCTM initiated a conference to develop a research agenda to identify needed research in mathematics education and to guide the research activities of the Council. The *Research Agenda Conference Report* (Arbaugh et al., 2010) followed as a response to the Task Force's recommendations and to broader calls for education research to focus on problems of practice and for teaching practice to draw on evidence from empirical research (e.g., Burkhardt & Schoenfeld, 2003), as illustrated by two examples provided in the report. A key contribution of the report is a set of research-guiding questions that suggest areas in which knowledge from research can inform improved practice and in which current efforts in practice provide a foundation for research.

As the standing committee of NCTM charged with disseminating to practitioners mathematics education ideas that have been investigated by researchers, collaborating with other groups to identify research topics to inform decision-making, and cosponsoring the Research Presession, the NCTM Research Committee established a new program in 2010 to honor exceptional publications of research-based

knowledge in NCTM's journals for teachers. To underscore and facilitate recognition of the work of researchers who exemplify building these connections, the Linking Research and Practice Outstanding Publication Award recognizes one article in each practitioner journal—*Teaching Children Mathematics, Mathematics Teaching in the Middle School*, and *Mathematics Teacher*—that exhibits strong connections between research and practice as well as excellence in reporting.

Encouraged by the NCTM president and Board of Directors, our committee identified many candidates for the award in its inaugural year that reflected synergies of research and practice. Discussing the substance and approach of these articles, in particular how they manifested strong connections between research and practice, led to the development of six criteria for selecting finalists and award winners (Figure 1). We suggest that these six criteria offer a useful set of guidelines for researchers seeking to forge stronger linkages with practitioners. The first three award-winning articles, listed in Figure 2, provide excellent examples to illustrate the application of these ideas in reporting research in venues geared to practitioners.

The authors of these articles also offered insights about their work to provide views about the design and conduct of their research to complement the dissemi-

1. The article addresses an important and timely topic.
2. The article is explicitly grounded in the author's research program.
3. The research is pertinent to both the content of school mathematics and the work of practitioners.
4. The article is well connected to practice through the use of rich examples, episodes, or cases that illuminate the key ideas.
5. The article offers a clear set of recommendations that can be readily applied to a teacher's own practice to aid in the improvement of teaching.
6. The research represents a collaborative endeavor (partnership) between teacher educators/researchers and classroom teachers.

Figure 1. Linking Research and Practice Outstanding Publication Award criteria.

Star, J. R., Kenyon, M., Joiner, R. M., & Rittle-Johnson, B. (2010). Research, reflection, practice: Comparison helps students learn to be better estimators. *Teaching Children Mathematics, 16,* 557–563.

Little, C. A., Hauser, S., & Corbishley, J. (2009). Constructing complexity for differentiated learning. *Mathematics Teaching in the Middle School, 15,* 34–42.

Cirillo, M., Drake, C., & Herbel-Eisenmann, B. (2009). Contemporary curriculum issues: Curriculum vision and coherence: Adapting curriculum to focus on authentic mathematics. *Mathematics Teacher, 103,* 70–75.

Figure 2. Linking Research and Practice Outstanding Publication Award winners, 2011.

nated products of this work. To provide these views, the Research Committee asked each of the authors to respond to a short set of questions by e-mail.

For authors who are teachers in K–12 schools, the questions were the following:

- Why do you consider it important to your teaching practice to be involved in a research program?
- How have your knowledge, experience, and perspectives as a practitioner influenced the research in which you have been involved?
- How do you craft publications and conference presentations from your research to appeal to fellow practitioners and inform their practice?

For authors whose primary responsibility is research, the questions were these:

- How do you involve practitioners' perspectives in shaping your overall research program?
- How do you involve practitioners' perspectives in designing and conducting your research?
- How do you craft particular publications and conference presentations to appeal to practitioners and inform their practice?

In the sections that follow, we consider each criterion in terms of the guidance it suggests for mathematics education researchers seeking to conduct research that connects strongly with practice and, more specifically, to disseminate results from their work in outlets for practitioners. Although we maintain as a primary focus the reporting of research in products for mathematics education practitioners, we also acknowledge aspects of the design and conduct of research that provide the foundation for such reporting. Finally, we suggest some broader implications for the field for linking research and practice that derive from these guidelines.

GUIDELINES FOR REPORTING RESEARCH FOR PRACTITIONERS

Addressing Important and Timely Topics

The criteria for publication in NCTM's journals calls for articles with the potential for direct classroom application, especially those providing evidence of classroom practice, and the peer review process essentially ensures that the topics addressed in all articles published in the practitioner journals address important and timely topics. As a guideline for researchers, however, it is how researchers choose their topics and make a case for the importance and timeliness of their choices that matter. An author of the *Mathematics Teaching in the Middle School* article noted the importance of ". . . paying attention to what the current issues are in the larger educational community and trying to stay as much as possible on the questions that are most relevant and timely, while still grounding everything in a larger conceptual understanding of the field" (C. Little, personal communication, September 9, 2011).

To claim that a topic is important and timely is not nearly as useful as crafting a

compelling argument for its importance and timeliness when communicating to practitioners. In their article in *Teaching Children Mathematics*, Star, Kenyon, Joiner, and Rittle-Johnson (2010) made a case for the importance of instruction deliberately aimed at developing elementary-grades students' strategies for estimation, noting that:

> Estimation is more difficult and complicated to young learners than it might appear to experts and teachers. When estimating, students must make choices as to how they want to calculate. For example, many estimation techniques involve rounding; however, students must choose which number—or even which place value—to round. Given the wide variety of options, such choices can be daunting to a young learner. . . .
>
> Students must decide not only among numerous strategies when estimating but also, depending on which strategy they choose, whether a given situation merits an estimate that is easy to perform or one that is close to the exact value of the calculation. Accomplishing both goals simultaneously can be challenging. (p. 557)

Here the authors argue for the importance of the topic they are addressing by unpacking the decision making that underlies both the process and the need to consider precision in choosing an estimation strategy. The argument they make is not limited to noting that estimation is an important skill, but rather that it involves a specific set of unique cognitive challenges for elementary grade learners.

A different kind of case for the importance and timeliness of strategies for differentiation of tasks in middle-grades mathematics appeared in Little, Hauser, and Corbishley's article (2009) in *Mathematics Teaching in the Middle School*. They suggest that this topic has particular importance in the middle grades because the differentiation of tasks can support students' progress toward increasingly abstract mathematics concepts:

> As students move from concrete numbers into variables, a higher level of abstraction is introduced. In the more advanced courses of algebra, geometry, and trigonometry in high school, teachers present material that is naturally more abstract than much of what students have previously experienced. Thus, it is helpful for middle school students to grapple with problems that introduce increasing layers that balance concreteness and abstraction adjusted for student readiness. (Little et al., 2009, p. 39)

Authors of the award-winning articles offered additional insights about how they think about the importance and timeliness of the topics they investigate, particularly in terms of choosing specific research-based ideas to communicate in venues for practitioners. One noted that when considering research ideas to share with practitioners, she initially asks herself, "What about this [idea] do I most wish I had known when I was teaching? Answering this question has actually shaped most of the articles I've written for NCTM teaching journals and books" (B. Herbel-Eisenmann, personal communication, August 19, 2011).

Explicit Grounding in a Research Program

Linking research and practice means more than ensuring that recommendations for practice have a basis in empirical data. In a recent article, the NCTM Research

Committee (2009) offered recommendations for researchers to structure their programs of work to promote coherence and connections to practice. The criteria for explicit grounding in a program of research are closely related to these recommendations, particularly as they relate to how research is reported in venues designed for practitioners. It is useful for a number of reasons to make the larger program of research within which a study is situated explicit in communications to practitioners.

First, as an audience for research, practitioners will be served well if they encounter research-based ideas framed within a larger set of inquiries. The number of research-based ideas that a teacher might encounter in a single journal issue or at one conference poses a real risk of fostering incoherence in how teachers make sense of and apply those ideas in their practice. Researchers can situate the ideas they share with practitioners to foster coherence, so that any one strategy or recommendation can be located within broader considerations of teaching practice. Products for practitioners arising from research programs that are designed around theories of curriculum, assessment, teaching, learning, or other aspects of mathematics education ought to make the key elements of those theories evident to practitioners to promote coherence.

Second, as they are increasingly being asked to adopt and incorporate "research-based" practices, practitioners will benefit from opportunities to learn more about the research base in which those practices are grounded. It is important that they understand both the context in which recommendations for practice are generated and the evidence on which they are based. Having access to such information may also be helpful for a practitioner to discuss a new practice with a colleague, administrator, or parent. Moreover, as consumers of research, practitioners ought to develop a critical eye for a sound evidence base and recognize that the level of evidence should influence their level of confidence in the recommendations. As they consider or incorporate new ideas or strategies into their practice, they can reflect on the application of those ideas or strategies in terms of similarities and differences between the contexts of their work and the research situations in which the research-based evidence was generated.

Finally, practitioners who find an interesting idea, or who incorporate it into their practice, will likely seek out more information. Pointers to other publications and products, both those designed for practitioners and those available in outlets geared more to researchers, offer practitioners a way to extend their learning. All three of the articles selected for the inaugural award offer excellent examples of how the context and nature of the broader research programs are shared with the practitioner audience.

For example, in their *Mathematics Teaching in the Middle School* article, Little and colleagues (2009) share that, "This article grew out of a study that explored how the challenge level of learning tasks is connected to behavior for students who show strong potential in mathematics but are frequently off task" (p. 36). In addition to alerting practitioners to the larger program of research, the authors inform readers that the strategies for differentiation that are shared in this article were being investigated for a specific purpose with a particular group of students in mind.

Practitioners who are reading this article are likely to know something about differentiated instruction because it is a widely discussed topic in mathematics education. Understanding the focus of the research program behind this article provides a way to situate the strategies it offers for differentiating tasks relative to that purpose and the students for whom it is intended.

An author of one of the articles commented about how spending part of his career as a classroom teacher has shaped his current research program, "Similar to many teachers, I was deeply concerned with helping my students understand the mathematics that they were learning in my class, and I was troubled when, despite my best efforts, students continued to struggle" (J. R. Star, personal communication, August 19, 2011). This sense of his own experience as one shared by other practitioners ultimately influenced the choice of topics to investigate, and the nature of the research he conducts:

> As a former middle/high school mathematics teacher, my entire research program is and always has been grounded in problems that I experienced as a practitioner. . . . I still remember specific students and specific instructional situations from my classes—and my research program is designed to specifically address the challenges that my students faced in my classrooms. . . . In my research program, I have tried to better understand why my students may have been struggling, and I have tried to design instructional interventions that I think would help students to better understand and appreciate mathematics. (J. R. Star, personal communication, August 19, 2011)

Because no single study by itself is likely to provide a strong empirical basis for a result, practitioners may have relatively low confidence in the study's recommendations. However, by grounding a study within the author's research program or—better yet—the field's research literature, practitioners can place greater confidence in the recommendations for practice that are made.

Pertinence to School Mathematics and the Work of Practitioners

The goal of reporting research in venues for practitioners to link research and practice should not be layering more and more research-based ideas onto existing practice. Rather, we argue it should be to aid teachers in refining and deepening the quality of practice through an inquiring professional stance about their work. A guideline for researchers that emphasizes reporting results in ways that are pertinent to school mathematics, and the work of practitioners reflects this view. Research-based publications and presentations typically offer teachers a new way to conduct or to think about some aspect of their work. This guideline stresses the importance of specificity in making such recommendations to practitioners. Clearly communicating the study's implications for practitioners' work (e.g., mathematics content, pedagogy, curriculum, assessment) will aid teachers in considering decisions about their practice.

As a part of providing such specificity, practitioners can view new possibilities for their practice as something that will help them improve, or extend the benefits of, something that is already a part of their work. It seems unlikely that new strategies or new ways of thinking about practice will have a positive influence if the

likely reaction is, "When will I ever fit that idea in?" Offering a clear sense of where a new idea or strategy fits to address an existing need can offer practitioners motivation and parameters for considering something new as a connected part of their practice, rather than as yet another thing to do.

In their article in *Mathematics Teacher*, Cirillo, Drake, and Herbel-Eisenmann (2009) situated their work on curriculum vision as described below. The components of curriculum vision they investigated are likely familiar, and potentially quite challenging, in the work of teaching. It is notable how the authoring team described curriculum vision as an idea that brings together various knowledge bases on which teachers draw in their practice:

> In this article, we describe *curriculum vision*, which includes an understanding of the mathematics that students must learn and a coherent trajectory (or set of trajectories) for learning that mathematics. Teachers who manage the complex task of attending to students' needs as well as to standards and objectives should have a well-defined curriculum vision, and we offer suggestions for how they might begin to reflect on and articulate this vision. . . . A teacher with a well-defined curriculum vision must have a deep understanding of (1) the curriculum's big mathematical ideas or goals; (2) the multiple trajectories students might follow to reach those goals; and (3) the strategies for using, adapting, supplementing, or creating curriculum materials to support students in reaching those goals. Finally, an important component of curriculum vision is curriculum coherence—mathematical connections that can be made by both students and teachers—within and across lessons. (Cirillo et al., 2009, p. 71)

Among the authors of the article in *Mathematics Teaching in the Middle School* is a practitioner–researcher, who shared that her part in the study arose from curiosities about aspects of her own practice. She commented that "research appeals to me as a way to get some of my questions answered," adding:

> I had heard in all of my theory classes about how important differentiation was. I knew that I needed to be able to challenge some students and provide more scaffolds for others, but having that knowledge and doing something with it are very different. I wanted to know what aspects of the task I would need to change to make it more challenging in a way that would meet a student's needs without creating an entirely different problem. I think practical experience produces these questions and also helps inform the way you think and the ideas you have as you go about answering them. (S. Hauser, personal communication, October 24, 2011)

Similar ideas were used in the article to situate the research study and results for the practitioner audience, describing specific aspects of the work entailed in applying differentiation strategies. Also central to this description, and a key part of this guideline, is an emphasis on maintaining worthwhile mathematics content learning objectives, something that could be compromised in differentiating tasks.

> Tiering for readiness begins with selecting or developing a worthwhile learning task that will help students achieve one or more meaningful objectives. Then a teacher develops several adjusted versions of the task, with the same or similar objectives, based on students' assessed needs (Tomlinson, 2003). For example, some students may need assignments that have more complexity or abstraction; others might need more concrete tasks. Developing the tiers may involve constructing new problems or carefully selecting and distributing existing problems. By selecting or designing tiers

> around the same core mathematical ideas and processes and by starting from a worthwhile task, teachers can also then assess all students' progress toward the core objectives. (Little et al., 2009, p. 37)

Connection to Practice Through Rich Examples, Episodes, or Cases

Encountering a research-based strategy or idea that offers a way to refine or reconceptualize practice invites a practitioner into a thought experiment around the question: What would it mean to do this in my practice? Offering practitioners opportunities to engage in vicarious experiences (Stake, 1983) is a strategy for facilitating their processing of this key question. Illustrating an idea or strategy, as it is manifest in practice, can provide a concrete image to promote understanding of how the idea or strategy is used in design or implementation. Examples, episodes, or cases of the idea or strategy also provide a platform for researchers to convey an analytic account, pointing out how key aspects of the theory and rationale for the idea or strategy are embodied in design, how they are maintained in implementation, and how they are expected to lead to intended results.

The use of rich examples, episodes, or cases also offers the practitioner audience the opportunity to apply existing and emergent thinking to situations they might encounter in their own work. The benefits of engaging practitioners in analysis of artifacts of practice are well established in practice-based professional development in mathematics education (e.g., Stein, Smith, Henningsen, & Silver, 2000). In a broad sense, the reporting of research is an opportunity for professional development, and therefore it is sensible to capitalize on what the field has learned about means of structuring professional learning opportunities for practitioners. One of the authors described succinctly the approach of using examples or episodes to engage practitioner audiences in considering research-based ideas, writing, "I usually try to articulate one major point I wish I had known [as a teacher] and then draw on classroom transcripts and discussions with teachers to say this point in multiple ways" (B. Herbel-Eisenmann, personal communication, August 19, 2011).

An author of the article addressing differentiation of mathematics tasks in *Mathematics Teaching in the Middle School* provided a strong rationale for the strategic use of examples in reporting research for practitioners, writing:

> Throughout the article, we gave examples to illustrate our points, but these examples also had the benefit of giving other practitioners something concrete to work with. Rather than just discussing ideas, we demonstrated exactly what this differentiation might look like for a variety of mathematical topics. We tried to choose topics that were fairly representative of middle school mathematics so that teachers might be able to use those exact examples or something very similar if they needed a starting place. (S. Hauser, personal communication, August 19, 2011)

For example, consider the sample tasks (Figures 3 and 4) that the authoring team of the *Teaching Children Mathematics* article provided. In research articles, authors often provide samples such as these to illustrate the nature of an intervention that was investigated, an instrument that was used to collect data, or the nature of data that were collected. In articles for practitioners, these samples may serve similar

purposes, but, used strategically, they can do more to address the key points of this guideline. A practitioner reading this article has an opportunity to examine the two versions of the tasks presented to students and to consider more concretely the implications of the study's results for students' learning opportunities.

Offer Recommendations That Can Be Applied Readily to Practice

Developing a product from research, in addition to adhering to standards for conducting and reporting (American Educational Research Association, 2006), ultimately entails communicating results to address the question, "So what?" Reporting a research-based idea or strategy with the intent to influence practitioners' work, in addition to answering this question, also needs to answer the question, "Now what?" Making a convincing argument that a particular idea or strategy offers a powerful new way to conduct or think about mathematics education practice is unlikely to make much of a difference unless practitioners have a clear sense of how they can bring those ideas or strategies into their practice. They might do this first by experimenting and making further sense of what they have learned and ultimately to incorporate those ideas and strategies they find successful into the regular routines of their work.

Such recommendations are exemplified in the article reporting research on approaches for teaching estimation in the elementary grades:

> How can teachers harness the power of comparison when teaching estimation? First, the results of this study underscore the importance of assessing and then building on students' prior knowledge of estimation strategies. For example, assessing students' prior knowledge showed that many students in the study began as fluent users of the round-both strategy for computing estimates. Students' comfort with the round-both strategy was a key asset when this strategy was compared to other, less familiar strategies such as round one and trunc. At the same time, the assessments of students' prior knowledge indicated that some students mistakenly believed that round both was the *only* way to compute an estimate. In such cases, comparison both increased students' repertoire of estimation strategies and encouraged students to evaluate whether a strategy was most appropriate for a given problem.
>
> A second important way that teachers can use comparison to teach estimation is through classroom discussion. Opportunities for students to identify similarities and differences in strategies were embedded in the written instructional materials in this study as well as in prompts encouraging them to think about the strategies' efficiency. (Star et al., 2010, p. 562)

An essential feature of these recommendations is their specificity about how and why to apply the strategy to practice. A reader who is compelled to experiment with this idea in practice has clear guidance for some ways to do so, as well as suggestions about what they might expect from their students when they first engage in instructional activities incorporating this strategy, and what might constitute genuine evidence of student progress.

The reporting of research can aid the application of research-based ideas to practice through carefully communicated recommendations for practitioners. Clear

Students in the compare condition received sample packets that showed side-by-side examples of strategies.

About how much is 27 × 43?

Allie's Way	Claire's Way
27 × 43 My estimate is 800. I covered the ones digits and then multiplied the tens digits like this: 2■ × 4■ = 8 Then I added two zeros, because I covered two digits, and got 800.	27 × 43 My estimate is 1200. I rounded both numbers. I rounded 27 up to 30, and I rounded 43 down to 40. Then I multiplied 30 × 40 and got 1200.

3. How is Allie's way similar to Claire's way?

4. a. Use Allie's way to estimate 21 × 43.

   b. Would Claire's way give an estimate for 21 × 43 that is different from Allie's way?

Figure 3. Sample tasks from Star et al., 2010, p. 558.

The sample packet for the sequential condition showed strategies separately, on different pages.

About how much is 57 × 23?

Claire's Way
57 × 23 My estimate is 1200. I rounded both numbers. I rounded 57 up to 60, and I rounded 23 down to 20. Then I multiplied 60 × 20 and got 1200.

2. a. Is this an OK estimate?
   ____ Yes ____ No

   b. How do you decide if an estimate is OK?

About how much is 27 × 43?

Allie's Way
27 × 43 My estimate is 800. I covered the ones digits and then multiplied the tens digits like this: 2■ × 4■ = 8 Then I added two zeros, because I covered two digits, and got 800.

4. a. Use Allie's way to estimate 21 × 43.

   b. Did Allie get the same estimate for these two number problems?

Figure 4. Sample tasks from Star et al., 2010, p. 559.

and concise suggestions, often crafted as practical frameworks or sets of questions with direct application to specific aspects of planning, carrying out, and/or reflecting on practice, can encapsulate the results and implications of research so they can be readily translated into teaching practices. Although it is important to offer suggestions to encourage the application of ideas or strategies to practice, it is perhaps most important to frame these suggestions in ways that promote reflection, as one of the authors of the *Mathematics Teaching in the Middle School* article described efforts to "ensure that there are some short, useful tips that anyone can take away, but also some 'meatier' material that people can explore or reflect on more thoroughly" (C. Little, personal communication, September 9, 2011).

Practitioners who encounter a new idea or strategy and use it in their practice are likely to learn far more if they can analyze the design, implementation, and results of their endeavors. When reporting research in venues for practitioners, we strongly recommend providing prompts that foster reflection on practitioners' experiences, whether individually or with colleagues in communities of practice. In many instances, the same recommendations for implementing an idea or designing a strategy, or an explication of the intended influences on, or effects of, practice can form the basis for reflection. Explicitly describing how to use these recommendations or expectations to support reflection would seem to make it much more likely that practitioners will use them in this way. It also is worth considering a broad range of practitioners among the audience. A tool that is useful for individual reflection also may prove powerful for the work that teacher leaders, mentors, or mathematics coaches do with individuals or groups of teachers.

The authors of the article on curriculum vision appearing in *Mathematics Teacher* (Cirillo et al., 2009) provided the set of questions shown in Figure 5 as a tool for practitioners to take stock of their current practice with respect to the ideas reported in the article. This set of questions operationalizes the ideas of curriculum vision and coherence, providing specific meaning to those terms that practitioners can connect with their own experiences. Those terms can subsequently encapsulate specific aspects of practice, both for individual reflection and potentially for discussions with colleagues engaged in collaborative examinations of their practice focused on the ideas. They also can provide practitioners and researchers common ground to further inquiries and conversations (National Research Council, 2001).

To engage readers further in thinking about the use of this set of questions, the authors described some examples of the form that these questions could take when applied to specific teaching situations:

> For example, teachers might ask themselves, "How much emphasis should I place on functions in each of my courses?" Another question relates to whether the curriculum is coherent and focused: "How can I create coherence or connections across these ideas, rather than treating them as a collection of topics? For example, how can I connect functions to regression analysis?" In addition, it is important to reflect on *how* the content will be taught: "What are the ways through which I want my students to acquire and use this content knowledge? For example, how might I teach theorems and properties of triangles in geometry and provide my students with opportunities to engage in the Process Standards?" (Cirillo et al., 2009, p. 72)

Developing Curriculum Vision and Coherence

- What are the "big ideas" (the important mathematical content) that I want students to learn?
- Is my curriculum one that is coherent and focused rather than a collection of activities or topics? How do I create coherence or connections across these ideas?
- What are the ways through which I want my students to acquire and use this content knowledge? In other words, how can I teach this content while still addressing the important mathematical processes?
- What do I see as the balance among skills, procedures, and concepts?
- How do my own knowledge, beliefs, and experiences fit into this vision?
- How do my individual students' needs influence my curriculum vision?
- How do I consider particular features of high-quality mathematics education (e.g., NCTM's Principles) as guides and tools for making decisions about curriculum?

Figure 5. Questions from Cirillo et al., 2009, p. 72.

Similarly, the *Mathematics Teaching in the Middle School* article offered recommendations in the form of "Key ideas for successful differentiation" as shown in Figure 6.

Significant in this set of recommendations is its clarity as a set of parameters that can guide not only what to do but also what to keep in mind when seeking to incorporate this idea in practice. Each of the recommendations can serve to guide decisions in design, prompt actions in implementation, and generate questions for reflection as a practitioner engages in efforts to differentiate tasks for learning.

In offering recommendations from research for practitioners, we argue that the recommendations should not just offer a portrait of excellent, full-blown applications of new ideas or strategies in practice. Having that vision of a new idea or strategy in practice is important—practitioners need to know what it looks like—but, in our view, it is not sufficient. Effectively illustrated in each of the preceding examples, we suggest that recommendations for practitioners provide not only a starting point but also a means to make progress as one engages with a new idea or strategy. Moreover, recommendations that provide indicators of progress can serve as a tool for practitioners to engage in self-assessment of their practices.

Create Collaborations of Researchers and Practitioners

One direct approach to forging links between research and practice is to engage in collaborations involving teams of researchers and practitioners. Alternatively, individuals may blend research and practice in their own work. Although this suggestion may seem obvious, some of the benefits of these collaborative efforts

Key Ideas for Successful Differentiation

The following ideas will help you provide differentiated instruction for all students:

- Start small. Use materials that you are already working with and adjust them to respond to varied needs around your objectives.
- Promote growth for all learners; keep struggling, grade-level, and advanced students in mind.
- Give all students access to rich, worthwhile tasks and ideas that encourage higher-level thinking and mathematical applications.
- Adjust the number of tasks along with the complexity, but avoid giving any group of students significantly more or fewer problems to solve.
- Use assessment continuously, and group flexibly according to assessed needs.
- Recognize that some students may have needs beyond what can be met with tiering.

Figure 6. Recommendations from Little et al., 2009, p. 39.

deserve careful attention in terms of how they can inform the design and conduct of research as well as guide the reporting of research in outlets for practitioners.

Collaborative teams of practitioners and researchers have an advantage addressing the first five guidelines delineated previously. The combined perspectives of researchers and practitioners provide the professional interests, experiences, and propensities to balance strong conceptual framing and empirical reporting with grounding and recommendations that can appeal to practitioners; guide their engagement, decision-making, and action; and support them in reflecting on and making sense of their experiences.

In a very practical sense, a collaborative team of practitioners and researchers has the means to field test the practices they intend to describe and recommend to classroom teachers. In fact, such collaborations may grow out of efforts to do exactly that, establishing the basis for collaborations that transcend a traditional relationship of researcher as investigator and practitioner as a part of the testing and proving ground for the investigation. Involving researchers and practitioners together in designing, implementing, and reflecting on practice, as well as analyzing and interpreting data, brings complementary perspectives to both research and practice. As a result, research can yield more authentic and applicable findings, and practice can improve through careful integration of strategies with a sound empirical basis.

It is notable that of the three inaugural award-winning articles, the authoring teams for two of them included both K–12 practitioner–researchers and university-level researchers, some with K–12 teaching backgrounds. The other authoring team, three current university-level researchers, all have classroom teaching

experience and work very closely with K–12 practitioners in their research programs. The authors of the various articles offered a number of thoughtful insights about how they conduct work in collaborative teams, and the benefits of doing so, as highlighted in the four examples that follow:

> My overall research program . . . draws on the expertise of practitioners to both build theory and speak to practitioners and problems of practice. . . . My research is driven by a cycle of (1) identifying "problems" of practice (through my interactions with teachers and/or through my own experiences as a teacher and teacher educator), (2) understanding existing theory related to those problems of practice, (3) designing and enacting research in collaboration with practitioners in order to elicit and understand their expertise related to the problem, (4) using what I have learned from practitioners to both build theory and develop materials to support practitioners in addressing these problems of practice. (C. Drake, personal communication, September 7, 2011)

> I think that teachers are conducting "action research" all the time as they try a new idea, lesson, or strategy in the classroom. Getting involved in a research program is just the next step. Since formal research is more organized and controlled, you can get a better idea of why or how something works instead of just that it works. I also think that it helps me to feel like I'm contributing to the field of education in a new way. We all know that there are problems of practice and this is a way to try to address some of them and create new ideas that might benefit the whole field, which ultimately benefits more students. (S. Hauser, personal communication, August 19, 2011)

> I think about collaborating with teachers as a partnership where we come together to understand and address a challenge of teaching mathematics. Once we understand the issue and develop ideas for addressing it, the new ideas will need to be tried out in classrooms with students. I cannot do this work alone. I need teachers who are willing to work to develop and revise tools and strategies for tackling these challenges, take risks, and try out the new ideas. I am fortunate to have partnered with teachers who were willing to engage with me in this manner. (M. Cirillo, personal communication, September 7, 2011)

> I try to involve practitioners in the design and implementation of my research. First, . . . research assistants typically are fresh out of the classroom and thus are often more deeply connected with practice than I am. Second, I involve practitioners whenever possible in all aspects of my work. Sometimes I hire practitioners to work . . . in producing study materials; sometimes I seek informal guidance and feedback from practitioners. Third, . . . preservice teachers [I teach] bring important and interesting perspectives and questions with them as they are learning how to teach mathematics. I find it to be very valuable to be continually reminded of these perspectives and questions as I design my research studies. (J. R. Star, personal communication, August 19, 2011)

Each of these statements calls for collaborations among researchers and practitioners, which, although built on the strengths and formal experiences of different roles, are fluid in the nature of all parties' participation in research and practice. They suggest that in different efforts, and at various times within a particular research endeavor, it is beneficial for practitioners to become involved in research through varying degrees and types of commitments. Openness to different types of researcher–practitioner collaborations both respects the expertise of those whose primary roles involve either research or practice and invites involvement that crosses

traditional boundaries to provide new learning opportunities. Notably, those learning opportunities can benefit both the individuals directly involved and the researcher–practitioner audiences that stand to gain from the products of the research.

DISCUSSION

Drawing on the criteria established for selecting articles published in NCTM's journals for teachers to receive the Linking Research and Practice Outstanding Publication Award, we have offered a set of guidelines for reporting mathematics education research in outlets designed for practitioners. We have used examples from the three award-winning articles in the inaugural year of this award program to illustrate these guidelines. The most direct application of these guidelines is for researchers to consider them in terms of reporting results in articles intended for practitioners and the implications for how they design and conduct studies within their research programs. An author of one of the award-winning articles shared this with the Research Committee:

> Several years ago, I received some advice . . . that whenever we learn something from our research, it is our responsibility to disseminate it, not just to a research audience but also to disseminate it to practitioners through a companion piece in one of the NCTM journals. . . . After all, it is the classroom teachers who have the direct contact with the students on a daily basis. (M. Cirillo, personal communication, September 7, 2011)

Individuals reporting research in outlets for practitioners may find these guidelines useful for their own development. Taking a wider view, if the field of mathematics education values reporting research for the sake of benefitting practitioners, then we need to develop a better collective sense of expectations for this type of reporting, which may be partially captured in these guidelines.

Additionally, we strongly believe that these guidelines have uses and implications that extend beyond how research is written for a teacher-practitioner audience. First, although the criteria for the Linking Research and Practice Outstanding Publication Award were developed specifically to examine articles written for teachers as practitioners, we have deliberately avoided limiting our presentation of the guidelines to classroom teachers as the only practitioner audience. We have opted instead to maintain a broader focus on mathematics education practitioners, inclusive of teachers, teacher leaders, district mathematics or curriculum supervisors, professional development providers, teacher educators, and others. As noted in the introduction, these various practitioners comprise the membership of NCTM and the readership of its journals and other publications. We consider the guidelines equally appropriate for reporting research when any of these practitioner groups are among the audience. The implication for researchers is to think broadly about a wide range of practitioners to whom their work might apply, and to seek outlets that are likely to reach those practitioners. To apply the guidelines we have offered to products for a range of practitioners, it is critical that researchers take account of the decisions and actions of the audiences they desire to reach. It simply is not possible to apply the guidelines (e.g., pertinence to the work of practitioners) without a clear sense of what the practitioners in the audience actually do in their work.

Second, although we drew illustrative examples from written products, we believe that these guidelines can be applied equally well to other means of reporting on research for practitioners. An appropriate example is presentations for practitioner audiences at local, regional, and national meetings of NCTM and its affiliates. These conferences offer specific opportunities for sessions that link research and practice. Particularly because presentation venues for reporting should be designed for strong engagement, not passive listening, of practitioners in the audience, we recommend using these guidelines to promote audience engagement. For instance, opportunities to connect to practice through rich examples, episodes, or cases, including structured activities to consider and apply recommendations to those examples, episodes, or cases, can motivate and foster active engagement.

Third, in our experience it is rare that the development of mathematics education researchers in doctoral programs, or even practitioner–researchers in master's programs, includes deliberate preparation regarding reporting research for practitioners. The *Research Agenda Conference Report* recommends that "established researchers need to encourage and support graduate students' contributions to practitioner journals and conferences" (Arbaugh et al., 2010, p. 41). Accordingly, we offer this set of guidelines as a starting point for bringing attention to this important aspect of mathematics education research. Many graduate programs feature "journal clubs" of faculty and students that read, discuss, and critique articles in research journals, in part, as a way of collectively developing knowledge and skills for crafting high-quality articles. We suggest that journal clubs could similarly choose articles in journals geared to practitioners, using the guidelines as a way to frame their reading, critique, and discussion. Graduate programs also commonly include writing groups of students and faculty who share drafts of papers with one another at various stages for peer feedback. Similarly, graduate programs frequently structure opportunities for students to practice presentations or share posters they are developing for conferences. The guidelines provided in this article may serve as a useful protocol for writing groups that share manuscripts being developed for practitioner audiences or for offering feedback on presentations or posters being developed to share with those audiences.

CONCLUSION

As described in the introduction, we are all members of a single profession of mathematics education. Forging strong connections between research and practice is essential for strengthening the profession. We developed the criteria for the Linking Research and Practice Outstanding Publication Award as a means to recognize excellence in forging these connections in one particular part of the profession. We have discussed them here as a way of inviting the community that comprises our profession to consider their broader applications and implications. We do so as a way of contributing to an exciting, and ongoing, conversation and movement about linking research and practice in our profession that is embodied in NCTM's foundational priorities and illustrated in many of the Council's products and activities. This movement is perhaps most evident in the *Research Agenda Conference Report* (Arbaugh et al., 2010). The report offers 25 research-guiding

questions intended to stimulate research on important problems of practice, with a subset of 10 questions considered in more detail. The guidelines we have introduced and illustrated in this article offer what we consider to be some essential elements of the "practice-guiding answers" that research can provide to such questions. Continued attention to how research addresses and reports on questions about key problems of practice is merited for advancing knowledge. Therefore, it is our hope that the guidelines we have offered may lay the groundwork for continued deliberation and conversation among the varied members of our profession about linking research and practice in mathematics education.

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