

Foreword: Building a Profession of Mathematics Teacher Education

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In *The Tipping Point: How Little Things Can Make a Big Difference*, Malcom Gladwell (2000) describes events from history in which relatively small, ordinary-appearing incidents have catalyzed a significant change in society. There is often a gradual build-up of attention and force for an idea, and then something tips the scales, a threshold is crossed, and big changes rapidly occur. In our view, this special issue could be a tipping point for the improvement of mathematics teacher preparation as a professional practice. It could redefine the work of mathematics teacher educators (MTEs) and trigger a new *collective* attention to preparing prospective elementary teachers (PTs) to teach mathematics.

Interest in our field for studying and improving teacher preparation in mathematics has steadily grown over the past years. But, we still live in Levine's (2006) "wild west" of teacher education. Teacher preparation programs mostly do their own thing. They rarely examine what other programs are doing and they fail to learn from others' experiences. Although our profession has a national organization focused on mathematics teacher education (the Association of Mathematics Teacher Educators), there have been few attempts to pull the field together around a common set of challenges. This special issue does just that.

Given the quality of the articles and the range of topics addressed, this issue could catalyze more systematic and collaborative efforts to improve mathematics teacher preparation. Although this issue might not go viral like some tipping points in Gladwell's book, it should become an important reference for those who engage seriously in studying and improving their own preparation program as well as for those who work to improve mathematics teacher

preparation more broadly. This issue is being published at a time when there is a growing interest among MTEs in listening to and learning from each other, and collaboratively building a knowledge base for mathematics teacher preparation. In this foreword, we foreground some of the authors' wide-ranging goals for teacher preparation along with their proposals for how best to achieve these goals. We then envision some steps that might be taken to increase the chances that this issue could become the tipping point that our profession desperately needs.

An Overabundance of Goals for Mathematics Teacher Preparation

Preparing elementary PTs to teach mathematics well is an overwhelming, sometimes impossible-looking task. There is so much PTs must learn and so little time. Authors in this issue identify the number, range, and complexities of competencies that PTs should develop during their preparation program. We think of these competencies as learning goals that could guide the curriculum for mathematics content courses for PTs.

First, prospective teachers must learn a new kind of mathematics that is needed for *teaching* mathematics. As described by Ball, Thames, and Phelps (2008), this mathematics is a decompressed or unpacked version of the mathematics they have learned to this point in their careers. Before entering teacher preparation, PTs have experienced a relentless push toward compressing mathematics. Problem solving strategies are abbreviated and symbolic expressions are compacted in order to prepare for more sophisticated strategies and expressions. Now, PTs are asked to decompress what they know so they can help children understand the full versions of the earliest strategies and symbolic expressions that enable them to do mathematics. As any instructor of mathematics courses for PTs can attest, this is not a trivial task. In our experience, even instructors who have strong backgrounds in mathematics must study the multiple ways decompressed mathematics can be represented and elementary problems can be solved.

The second goal extends the first goal by asking PTs to change their conceptions and beliefs about what mathematics is and what it means to know mathematics. Although instructors might not make this request explicitly, it is unavoidable as PTs realize they are relearning mathematics that they think they already know. People tend not to embrace opportunities to learn again something they believe they already know. This is especially true when the relearning experience is more challenging than the initial learning they remember. Why, PTs often ask, is the instructor making things so difficult when I just need to teach elementary mathematics? A good answer to this question requires PTs to change their long-held beliefs about mathematics, about what it means to learn and understand mathematics, and about what mathematics they need to know to teach it well.

A third learning goal for PTs is to understand how elementary school students represent this decompressed mathematics for themselves. How do these students think about mathematics? How can you, as a PT, make sense of their thinking? How can you connect the ways in which students think about mathematics with the new kind of mathematics you are learning in these courses? This learning goal is not independent of the first two goals because analyzing students' mathematical thinking can help PTs develop their own understanding of mathematics and can broaden their conceptions of mathematics.

The authors in this issue identify a number of additional learning goals that should be considered by MTEs who are making decisions about the curriculum for these mathematics courses. One such goal is developing PTs' knowledge of, and sensitivity to, issues of equity, diversity, and inclusion in teaching elementary school mathematics. What can you do, as a teacher, to maximize the chances that *all* of your students have rich opportunities to learn the important mathematics in your curriculum? Another goal proposed by authors is to help PTs

confront and decrease their mathematics anxiety, and to help them recognize ways in which they can help their own students do the same. Finally, some authors identified a goal of helping PTs become aware of the profession's standards and practices in mathematics that should inform their teaching.

Can All of these Goals Be Achieved in Teacher Preparation?

We believe readers will agree that all the learning goals the authors identify are important. But, can all of these goals be achieved in the limited time available in the mathematics courses included in elementary teacher preparation programs? Usually, programs allocate from 3 to 9 semester hours for mathematics courses. As MTEs know, there is never enough time to accomplish what is intended, even when the goals are a proper subset of those described above. So, the question about whether PTs can achieve the goals identified in the earlier section is not rhetorical. In our opinion, it is one of the most important and pressing questions for our field.

The authors in this issue recognize the reality of limited time and an abundance of worthy goals. A number of articles pose important questions about how to deal with the continuing tension between addressing more goals with less time per goal or addressing fewer goals more deeply. Drawing from the articles in this issue and from our own experience, we identify four relevant considerations that MTEs should take into account when deciding how to resolve these tensions.

A first consideration is perhaps the most fundamental: What mathematics, specifically, should be taught in content courses for PTs, and how deeply? Some of the authors in this special issue along with many readers have been involved in debates about this issue. Despite the attention it has received, our profession has developed no consensus. Some programs offer

survey courses that “cover” lots of material, whereas other programs offer courses that spend extensive time on only a few central topics. Breadth vs. depth is the most pressing problem for MTEs who teach mathematics courses for PTs.

We teach in a program that requires 9 semester hours of mathematics content. Twenty years ago, after intense debate, our faculty decided to commit to a few central topics and to teach them deeply. We have kept our learning goals stable in order to improve the curriculum and develop our expertise in teaching these topics. After 10 years of course improvement efforts, we followed several cohorts of PTs into their first 3-4 years of teaching. Based on responses to a range of tasks assessing mathematics knowledge for teaching gathered from graduates of our program, we have concluded that time spent studying a topic makes a difference (Hiebert, Berk, Miller, Gallivan, & Meikle, 2019; Hiebert, Miller, & Berk, 2017; Morris & Hiebert, 2017). This is not as obvious or simple as it might sound. We found that if PTs studied an important topic for only a few class sessions, they were unlikely to use anything they learned for teaching this topic themselves. If PTs studied a topic for several weeks, they were more likely to remember and use what they learned even 6-7 years after they took the course. But, they did not get close to ceiling effects on any teaching-like task. Apparently, they could have benefitted from even more instructional time with these topics. One inescapable conclusion is that survey courses, courses in which breadth is chosen over depth, are likely to be a waste of everyone’s time. Although these data were convincing for us, they were only gathered from graduates of one program. The critical question for the profession is how much depth (time) is sufficient to ensure that PTs retain and apply what they learned when they begin teaching.

A second consideration, related to the first, is how much “methods” to include in the content. Said differently, the question is how to represent decompressed mathematics in ways

that reveal the unique nature of the content PTs need to know. Earlier, we noted the value of studying children's thinking about mathematics because children's thinking can uncover mathematical *content* that PTs need to re-learn. For example, when fifth-graders are asked to find how many ribbons of length $\frac{2}{3}$ foot can be cut from a larger ribbon of length $1\frac{2}{3}$ foot, they sometimes say $2\frac{1}{3}$ because the length of the piece left over is $\frac{1}{3}$ foot. An issue is how to represent the remainder in a division problem, an important mathematical concept that can be revealed by analyzing children's thinking. The question is what other teaching settings (e.g., concrete materials, content standards, curriculum materials, instructional activities) could reveal important mathematics content, and what settings address only pedagogical issues. Sorting out the answer could help choose learning goals that should be included in mathematics courses.

A third consideration is how to select instructional tasks that help PTs achieve more than one learning goal. To make the best use of limited time, MTEs could create (or borrow) tasks that address multiple learning goals. By identifying mathematical concepts that cut across topics, and finding tasks that engage PTs with these concepts, perhaps mathematics courses could address more topics and address them more deeply. Although we find this to be an attractive approach to maximizing the limited time in mathematics courses, we caution readers who might assume this is somehow a full solution to the breadth vs. depth dilemma. In our experience, there is a limit to this theoretically appealing idea. However, creative work in this space is likely to produce more time-saving, high-impact learning tasks for these courses.

A fourth consideration is to tailor the curriculum of the mathematics courses to the entry competencies of PTs. Because our profession knows relatively little about the knowledge and skills with which many PTs enter these courses, it is likely that many courses are spending more time than needed covering material that PTs already know (at some level) and are missing topics

that instructors assume PTs have already been mastered. Using a logic similar to that which many MTEs convey to their students—build mathematics instruction on your students’ thinking—mathematics courses should be designed to focus on those topics for which PTs need the most help, and adjust the time spent on topics by taking account of PTs entry competencies.

Next Steps in the Pursuit of Improving Mathematics Teacher Preparation

Based on the articles in this issue, on the broader research literature, and on our own experience, we offer a blueprint for how our field could proceed if the goal is to steadily improve the effectiveness of mathematics courses for elementary PTs. The question we address is: What should MTEs do next so that 20 years from now they can look back and see that this issue was a tipping point for our profession?

1. Develop a Consensus on Learning Goals for the Courses

Perhaps the most urgent and difficult task for our field is to agree on learning goals for the mathematics courses. Unfortunately, it is necessarily the first step toward creating a profession-wide effort to improve. There is no way to move beyond the “wild west,” with each program making its own decisions, until multiple programs adopt the same learning goals. Learning from each other’s work is only possible to the extent, and at the level of detail, of shared learning goals. If several programs agree on learning goals at the level of mathematical topics (e.g., division of fractions), they can share ideas about how to help PTs develop competencies within a topic. But, if the programs devote different amounts of time to the same topic, or have different sub-goals within the larger topic goals, the shared information will be of limited value. On the other hand, if several programs agree on learning goals at the level of lessons, or class sessions, the information they share will allow collaborators to take full

advantage of what everyone is learning. Of course, agreement on goals at finer levels is more difficult.

Given the constraints under which individual programs operate (e.g., how many semester hours are dedicated to mathematics courses), it is likely that agreement on learning goals will need to be made among programs with similar constraints rather than among all preparation programs. Also, different programs might wish to adopt different profiles of goals by selecting among those proposed in this issue. Groups of programs might form among those that agree on similar goal profiles. None of these substantive differences among programs need to derail collaborations among like-minded programs. We believe MTEs need to keep two things in mind. First, no program, even one with 9 or more semester hours of mathematics, can achieve all the goals proposed in this issue. Every program needs to make difficult choices about which subset of learning goals to commit to, and by consequence, which learning goals will not be addressed. Second, well-structured collaboration should always be more productive than working alone. Larger pools of data and more ideas from more experts should create more effective programs.

2. Develop and Use Common Assessments

In order to share data among programs that is useful for everyone, common assessments must be used. Data are meaningful across sites only if MTEs can interpret PTs' responses in similar ways. This is critical because data on PTs' responses are the linchpin of improvements efforts. They determine whether changes to programs are actual improvements, or just changes. Data also enable building a knowledge base of practices in designing and implementing the mathematics courses that have been empirically tested and continually updated and improved.

Common assessments could play a critical role in at least three ways. First, they could help MTEs evaluate the relative effectiveness of different instructional approaches or activities in helping PTs achieve specified learning goals. Second, they could be used to follow PTs longitudinally after completing the mathematics courses to assess the effects of particular aspects of the courses on PTs' performance as they proceed through their program and into their teaching careers. These two uses of shared data could help programs collaborate around very challenging but important questions such as, "How much time must courses devote to particular topics to make a difference in the quality of graduates' classroom teaching?" A third use of common assessments could be to measure the entry knowledge and skills of entering PTs. This use could be enacted immediately because it does not depend on agreeing to common learning goals. Sharing data across sites will help MTEs develop a more informed perspective about how their programs might need to tailor courses somewhat differently than other sites.

3. Develop a Theory of Action for Improving the Courses

With agreed-upon learning goals and common assessments in place, MTEs need to develop a plan of action that will lead to improvements. For obvious reasons, programs that are collaborating need to develop a shared theory of action (also called implementation theories or improvement models; see Bryk, Gomez, Grunow, & LeMahieu, 2015; Lipsey, 1993; McKnight, Gallimore, & Johnson, 2008). Multiple theories or models could be envisioned. We will share a few elements of the continuous improvement model we have used at the University of Delaware (a more complete description can be found in Berk and Hiebert, 2009, and in Hiebert, Wieman, and Berk, 2018).

In addition to the selection of stable learning goals we mentioned earlier, our faculty colleagues joined us to develop a set of shared lesson plans for each class session of each course.

Although creating detailed written plans took several years, we found them necessary to enable instructors teaching different sections of the same course to interpret data across sections and to have meaningful discussions about possible improvements. Teaching from shared lesson plans enabled us to treat variations across sections as variations in student responses rather than variations in instruction.

The written lesson plans have served as both guides for instructors and repositories of knowledge we acquire for improving the course. Improvements are represented as tweaks to the written lesson plans with rationales inserted to remind future instructors of the reason for the changes. The process of inserting changes with rationales into the plans protects us from collective amnesia. It allows knowledge to be shared across instructors and across time. This part of our model ensures that the written plans are living documents, changing as instructors study their implementation and insert improvements.

A final element we mention here is that changes to lessons are based on data of PTs' learning and on the shared wisdom of instructors. Changes are made only when there is empirical evidence that a proposed change will help PTs better achieve the learning goals or when instructors pool their observations and agree that a change would improve the learning opportunities for PTs.

4. Build a Shared Knowledge Base for Mathematics Teacher Preparation

One mark of a true profession is that members of the profession contribute to, and draw from, a shared knowledge base for professional practice. Using that mark, our field is not yet a profession. But, it could be. MTEs are well positioned to build a shared knowledge base because, as evidenced by this special issue, they value the benefits of working collaboratively toward course improvements. In addition, many MTEs have the advantage of being both

practitioners and researchers. As practitioners, the knowledge they acquire teaching the courses is precisely the kind of knowledge that is useful for others (Hiebert, Gallimore, & Stigler, 2002). As researchers, they are able to vet this knowledge and apply standards that ensure the practitioner knowledge they share is valid and reliable.

Conclusion

We applaud the editors and authors for presenting a compelling display of the range and complexity of issues facing the field of elementary mathematics teacher preparation. We see this issue as a significant contribution to the literature on mathematics teacher preparation but, more importantly, as a call to action. It is a message to the field about the work that needs to be done and the importance of doing it. It would be fitting if the response of MTEs to reading these articles would cause the field to look back 20 years from now and celebrate this issue as a tipping point for mathematics teacher preparation.

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