Defining the Problem of Equity in Teaching Elementary School Mathematics

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This volume is concerned with the undergraduate university program and how it prepares its graduates to work in diverse societies. Our chapter focuses on a special subset of undergraduate students—those who go on to enter K–12 teaching as a profession. The impetus for this chapter is the recognition that although there are many ways in which adults engage in the life and work of a diverse society, one that is both central and often taken for granted is the work of teaching young people. Many university faculty members are unaware of how many students in their classes eventually become K–12 teachers and thus the extent to which they themselves are in fact engaged in the education of future teachers. As teachers work with youth, they represent the adult society for which young people are preparing. Teachers have the power to extend opportunity and expand individuals; they can also through their actions and interactions restrict both. In their role, teachers hold substantial power to affect society. Teachers are, of course, also profoundly shaped by their experience in that society. It is on this duality that our chapter focuses. We ask the question: How might undergraduate education contribute to a more equitable society by training those who will teach the next generation?

In this chapter, we examine how the preparation of undergraduate teacher candidates for a just and diverse society entails the design of practice-based pedagogies, which represent a significant departure from the typical undergraduate curriculum. We look in on a moment from a mathematics lesson in a third-grade classroom to illustrate the demands of teaching for equity, and how such examples of classroom practice can be the basis of a pedagogy that prepares teachers for diverse learners. We argue that teaching for a more equitable and just society demands a deliberate pedagogy of teacher education, one that is both centered on the practice of teaching and framed by theories drawn from the social sciences and the academic disciplines.

The Problem of Equity in Teaching Elementary Mathematics

A Practice-Based Pedagogy

Professional schools are concerned with what their graduates will do when they leave the university. Professional practice depends not only on skilled performance but also on the perspective enabled by a broad education. Teacher education seeks to prepare people for the complexities of the work they will do as teachers, and to do that work competently. This, we think, is served by a pedagogy based on practice, one that entails the use of typical problems that arise in the classroom, their “diagnoses” and treatment. This practice-based pedagogy would need to specify the work of teaching for equity, since if teaching in general is underspecified, as Glazer and others have argued, then the work of teaching in a diverse society is even less understood. As an example of this practice-focused teacher education design, we look to snippets of real practice to illustrate the complexity of considerations and demands of teaching in a diverse society, and to show how such snippets can be the basis for a practice-based teacher education that is concerned with teaching for a just and diverse society.

Consider the experience of the third-grade teacher in the following example. She is teaching a multicultural group of eight-year-olds who are working on the following mathematics problem:

a. I have one dozen small raisin cookies. If I want to share them equally with my family at supper tonight, how many cookies would each person get? How do you know?

b. How would this work out in YOUR family—how many cookies would each person get if YOU had a dozen cookies to share with them? How do you know?

The children copy the problem into their notebooks and, after some clarification, begin to work on solutions. Some of the children come from families with two, three, four, or six members, and so are easily able to divide the 12 cookies into an appropriate number of equal shares.

Cassandra, on the other hand, comes from a five-member family. This makes the problem challenging, because the class is just beginning to study fractions. Her discomfort about solving the problem is heightened by the fact that she is older and taller than her classmates, having been held back a grade earlier. In a class in which over half the pupils are from countries other than the United States, she is also one of only three African American students.

What happens in such little moments will shape who Cassandra becomes, and how she behaves. Her actions, in turn, will shape how others in
help close the achievement gap between white students and students of color, between middle-class students and those living in poverty. But too often it instead perpetuates inequality. To reverse this tendency, our system for educating new teachers has to accomplish two tasks: first, it must help educators-to-be to understand the challenges of a diverse society; and second, it must impart both the awareness and the skills they need to make schooling more equitable.

A History of Equity in Teaching Elementary School Mathematics

In America, educational achievement has long been correlated with race, ethnicity, class, and gender. The roots of this injustice lie buried in our past and entangled in our present, permeating classrooms, schools, and all of society. Bowles and Gintis argue that inequality is so tightly woven into the fabric of schooling that both teachers and students are (perhaps unwittingly) complicit, and urge their readers to consider how teachers can effect change in such a stratified and unequal system.

Complementing this analysis, sociologist Dan Lortie argues that the teaching profession tends to attract people who liked school themselves, and who implicitly accept the educational practices they grew up with. These experiences exert a major influence on how they behave as teachers. That is, their “apprenticeship of observation” imbues them with ideas about what teachers should do, and about what good teaching looks like. As members of society, these teachers are also “apprenticed” to commonly held ideas about race, class, and gender. Teacher education, according to Lortie, is a weak intervention on the powerful impressions and sense of knowledge that teachers bring from their own experience as students. The warrants for knowledge are more often personal than professional, as finding “what works for me” dominates much pedagogical reasoning. Lortie’s analysis of teaching suggests important ways in which the very nature of the occupation and socialization into its practice may reinforce, preserve, and reproduce inequality.

Lortie’s observations about the occupation of teaching, and its strong tendencies toward continuity, can be extended: Not only do teachers experience an apprenticeship of observation in schools, but, in addition, living in this society provides a powerful cultural apprenticeship with race, class, and gender. Teachers bring with them beliefs and attitudes, knowledge and patterns of action and interaction, values and perceptions that are the product of this apprenticeship. If teachers are to be able to teach all students,
professional education must be able to intervene effectively, in some cases, and make profitable use, in other cases, regarding these attitudes, knowledge, and skills.

As Lortie argues, however, professional education is a relatively weak treatment compared with the lessons of a lifetime. Nor does the strong individualistic ethos of the profession do much to challenge these prejudices.

Nowhere is this pattern of inequity harder to address, or professional culture harder to change, than in mathematics teaching and learning, where inequality manifests itself in consistent disparities in achievement scores. Because mathematics plays a key role in determining who will have access to college, funding, and a high-status career, this inequality leads to the exclusion of students from minority and other nondominant groups—either because their schools do not offer advanced mathematics courses or because tracking plays into a self-fulfilling prophecy of low expectations. This underrepresentation is most evident in university faculties, in advanced course enrollments, and in mathematics and mathematically based professions such as engineering, physics, and computer science. This observation has led Moses and Cobb to refer to mathematics education as the “new civil right.”

The work of Bowles and Gintis, Lortie, Moses and Cobb, and others makes it clear that in order to create a more just and equal learning environment, teacher-educators must help their students connect the challenges of actual classroom instruction to theories of learning and diversity that they may have read about in their coursework.

A Pedagogy of Practice: Contexts as Equity Work in Mathematics Teaching

Let us now return to Cassandra's third-grade classroom. How might a teacher-educator use this classroom example—a videotape of the class, as well as copies of transcripts, the children's work, and the teacher's field notes—to prepare future teachers?

Take, for example, the numerous theories about “context,” or real-life situations. There is a great push for the use of such real-life examples in mathematics teaching, in part because they make abstract mathematical concepts seem more relevant and immediate to the learner. This argument is especially common in discussions of mathematics learning among less privileged children, for whom math supposedly seems distant and irrelevant.

Teacher education students read a great deal about such ideas. They read policy documents that advocate the use of real-life contexts in mathematics, while this policy translated into curricula populated by story problems. Their instructors paint pictures of children working on such story problems, and of teachers using them to teach high-level mathematics.

But these traditional forms of teacher education cannot replicate the experience of working with real children. Policy documents, curricular materials, and portrayals of teaching are composed from words that someone else has chosen. The messiness that ensues in the classroom when children's feelings are at stake, when there are disparities in children's knowledge and experience, or when race, class, and gender differences come into play, are hard if not impossible to represent in lectures or textbooks. A future teacher's ability to disrupt the reproduction of inequality in the classroom can only be learned from professional training centered on practice.

By “practice” we do not mean the field experiences that are standard fare in current teacher education. Such experiences often confirm, rather than challenge, prior assumptions about race, class, gender, and children's ability to learn. Instead, we mean practice that can be queried using students' liberal arts knowledge. It may involve fieldwork in real schools, but it may also involve using records of practice: the videotapes, transcripts, and other documentation mentioned earlier. Unlike field experiences, students can pause on a record, query ideas and assumptions, insert questions of social (or mathematical or linguistic) import, consider alternatives, project children's learning, and the like.

These instructional designs allow teacher education students to tackle, with the help of their instructors, the taken-for-granted practices in school that perpetuate inequality. We have noted in particular a number of commonly accepted teaching practices—which we refer to as “defaults”—that we think have implications for equity in the mathematics classroom. The use of contexts, for example, is a default strategy for connecting academic learning to pupils' experiences. But a closer look reveals that relying on contexts can widen and intensify inequality, rather than reduce it.

But recognizing such defaults, and acting wisely in instruction, will involve more than reading about them. Knowing how to act in ways that advance equitable outcomes demands a pedagogy for teacher education that brings together ideas from theory and research, the mainstays of the liberal arts curriculum, with the particulars of practice, the heart of professional training.

Consider the experience with Cassandra in her third-grade classroom. The encounter with practice through the example of Cassandra's work could help prospective teachers understand how contexts introduce a host of issues that so-called bare mathematics does not. As Jill Adler has pointed out, the use of contexts forces us to confront questions about the universality of experience: about whether what may seem to one person a "basic" or "natural" problem (for example, about dividing cookies equally...
among family members) may in fact highlight differences in background or experience that lead to the subtle reproduction of inequality.  

These nuances become evident on videotape: by pausing the tape and poring over transcripts, a new teacher can see how subtle considerations about family, fairness, access to resources, and public persona come into play. These issues may seem easy to solve through abstract declarations of belief about diversity, but when viewed in the classroom setting their complexity becomes apparent.

Despite these challenges, the use of contexts is not optional. First, mathematics comprises a set of tools for framing, reasoning about, and solving problems in familiar settings—that is, in context. Second, mathematics teaching relies on students’ prior knowledge and experience to help them make connections to new situations and concepts. Third, nonmathematical contexts can help structure otherwise abstract mathematics learning. For example, the cookie problem could be understood as a “real-life” (i.e., applied) problem. But it could also be a means for structuring a lesson about the abstract concept of division with a fixed dividend and a variable divisor (the number 12, sharing equally, different numbers of people).

Thus, the use of contexts in mathematics instruction is not just nice, but necessary. Its unexamined use, however, is problematic when viewed from a perspective of equity and an awareness of privilege. Student teachers need to be sensitized to such problems if they are to succeed in fostering equitable classroom achievement. Pedagogical designs for this kind of work include use of “records of practice” such as videotape, transcriptions of talk, curriculum materials, children’s work, and teacher’s field notes. The object of study in this pedagogy is not the records themselves, but the reconstruction of practice using constructs from students’ liberal arts classes. Ideas about equality, equity, and the value and challenge of diversity in the classroom that come from readings and lectures become lenses through which practice can be judged. Unlike traditional pedagogy, there is little to be imparted by the instructor. Teacher education students are not empty vessels to be filled with ideas about equity. Rather, they are budding practitioners who need to be able to make inferences and judgments, as well as act, using such ideas as tools for their work.

As we do in teacher education, we return again to examples from practice to stay grounded in what our students will need to do. In the cookie problem, we would want teacher education students to notice, for example, that the teacher will have to use the concept of family carefully. Teachers assume that inclusion of family in the curriculum involves children’s lives in ways that make mathematics meaningful and engaging. Mostly true—but family structures vary enormously in twenty-first-century America, often in ways that are entangled with racial and class identities, and exercises like the cookie division may expose student sensitivities. Several students in Cassandra’s class live in single-parent homes, for example. Others have extended or nuclear family members who live at home intermittently. Prospective teachers may have encountered ideas about the fluidity of family structure in their sociology and psychology courses, but applied professional learning involves seeing how effective teachers are able to acknowledge these differences while still imparting mathematical knowledge. By observing records of practice, teacher education students may also see that the cookie problem is fraught because it involves food, and because it depends on a commonly understood definition of fairness, or what it means to share cookies equally. The understanding of such factors can vary tremendously across ethnic, cultural, and social lines.

Courting Diverse Interpretations of Practice

We step back now to consider how a university education might prepare teachers for the challenge of using contexts in mathematics in ways that are sensitive to issues of equity. To answer this question, we consider what a teacher would need to know in order to teach Cassandra. They would first need to know mathematics: not only the mathematics other college students learned in university, but a specialized version that will help the teacher convey mathematics to children. In our example, the teacher would need to recognize that the cookie problem is a partitive division problem, so that she could help her students set up strategies for working on the problem, or identifying where they went wrong. The teacher would also have to be fluent in her thinking about how best to represent this division problem—able to recognize that round cookies may be difficult for a child to divide into even fifths in a drawing, and that rectangular objects might be easier to manipulate.

Clearly coursework can help teachers ready themselves for the demands of their work. But typical university coursework is often insufficient to the task. And teaching also demands dispositions: the disposition, for example, to consider that context has equal potential to become a help or a hindrance in equitable math instruction. So how can universities fully prepare students for the demands of teaching?

This particular mathematics problem demands a kind of sensitivity to children’s varied definitions of “family” and an inclination to be inclusive when children choose to count different relations as family members. It requires a way of being in the world that systematically looks past one’s own experience, of not blindly presuming shared experience. Knowing that food has cultural and socioeconomic valences for children is also dispositional.
Skillfully navigating through children's conceptions of fairness requires a disposition to be open to the difference between the complex social concepts of “fairness” and “sharing,” and the mathematically cleaner notion of “equal.” Noticing and interpreting these issues requires multiple sets of eyes on watch. Not every student will see each of these; not every student comes with training, life experience, and personal background that render these issues readily apparent. Being able to apprehend the different meanings of family or fairness, to take two issues from our current examples, would depend on a pedagogy that invites multiple voices to comment on the Cassandra vignette. Undergraduates of varying backgrounds and prior experiences can contribute an array of insights if the design for this work includes collaborative discussion of the records of practice at hand. This, too, is part of the necessary pedagogy.

Courses in “multicultural education” or “social foundations of education,” too, aim to cultivate beliefs and dispositions about the effects of race, ethnicity, and social class in schooling. Such classes often focus on educating for democratic participation, on race as a social construct, and on the role of privilege in determining academic success. Even if undergraduates’ beliefs are in fact changed by reading about and discussing such issues, those changes will not necessarily help them to act when confronting inequality in real-life situations. Content knowledge and disposition are necessary but insufficient for skilled teaching. Cassandra’s teacher needs to know how to help her approach the mathematics problem and systematically consider the many different paths to a solution.

The skills and dispositions described here will not likely be acquired in the university classroom alone. They are more likely developed in some interaction of teachers’ field experiences, coursework, and personal histories. And the skills and dispositions that arise out of this mix do not emerge automatically. Consider, for example, the cultural and personal resources needed in teaching. These resources depend on a nuanced and self-conscious set of cultural sensitivities and competencies that are not automatically developed by growing up in one’s own environment, whatever that may be. University education can help to develop such competencies through deliberate exposure to cultural experiences that stretch and challenge the assumptions, perspectives, and practices tacit in one’s own experience. Immersion in other societies or milieus can help, if introduced in ways that bear on instruction, and contribute to these skills and dispositions. But this involves a conscious pedagogical design that brings such experiences to bear directly on experience in ways that are made public and accessible for all to learn from. Engaging with records of practice such as the videotape of Cassandra working on the cookie problem creates for teacher education students a virtual environment of practice in which teachers can craft possible teaching moves, in the company of peers and an experienced instructor.

Undergraduate Education and the Preparation of Teachers

We take the special case of teacher preparation in this chapter as an argument for the importance of diversity in the undergraduate curriculum more generally. We do so for a number of reasons.

First, teachers constitute the largest occupational group in the United States, and therefore deserve attention both for the education they receive and the education they produce. Because a university degree is required as a foundation for teaching in the United States, the lessons that teachers absorb during their college years will influence the education of children like Cassandra. The role of undergraduate education in shaping the effects of K–12 teaching for equity in a diverse society therefore warrants direct attention.

Second, because teacher education programs combine liberal arts and professional curricula, a great deal can be learned about undergraduate education as a whole by focusing on this particular area of specialization. Cassandra’s teacher in the vignette we have presented needs to possess both pedagogical skills and also enough mathematics expertise that she can help students like Cassandra learn to navigate new challenges successfully.

Third, teachers play a pivotal role in the creation and maintenance of a just society. Because the challenges and imperatives of diversity are central to effective teaching, as we have seen, understanding how we prepare teachers gives us a useful perspective on the broader challenges of life in a diverse society. Although we do not believe that teachers should shoulder this obligation alone, their contributions do shape learners’ lifelong opportunities for achievement and participation. It would have been easy, for example, for Cassandra’s teacher to pass over the halting solution she offered in favor of a more polished response from one of her classmates. Indeed, Cassandra herself suggested that another girl be allowed to demonstrate her solution instead. But the commitment to equity requires that the teacher help Cassandra craft a solid explanation that she can confidently present to the class, participating as a full and equal member.

Finally, we are interested not only in what university students learn to think about, but how they learn to act. Teacher performance is a limited but significant measure of what undergraduates learn to think and do. Cassandra’s teacher may have a host of ideas about equity in a diverse society. She may be committed to ensuring all children’s access to rigorous academic work. But she also may not have the tools necessary to act on these beliefs. The undergraduate experience for preservice teachers combines their lib-
eral arts education—ways to think—with their professional training—ways to act. Thus, the study of teacher education serves as a window onto the university's more general contribution to young people's ability to think about and act on notions of equity in a diverse society.

The liberal arts curriculum and experience form, unacknowledged, the major part of teachers' preparation for teaching. Prospective teachers study academic content that they will be responsible for passing on to their pupils. They encounter unfamiliar people and ideas. Most undergraduates are living and studying outside their communities of origin for the first time. Their assumptions and dispositions will be confronted and challenged as they develop into young adults who inhabit and shape our society. But while undergraduates are enjoying one of the greatest opportunities our society can offer—an education—their beliefs about the meritocratic nature of advancement and opportunity may be reinforced as privilege begets more privilege. The university experience can, in other words, unwittingly perpetuate the reproduction of inequality.

The demographic and intellectual diversity of higher education also creates a special opportunity for social change. It is not enough merely to pay tribute to the value of diversity; nor even to deliberately create a diverse educational community. Learning to be an agent for equity in a diverse society requires intentional education: challenge, discomfort, surprise, support, and reflection. The undergraduate education, in both its liberal and professional aspects, holds much possibility if it is consciously used toward these ends.

Education or Teacher Education?

We close with one final observation. Our focus here has been on how undergraduate education can become a force for change through its effect on future teachers: that is, on undergraduate education as teacher education. But learning does not end after childhood, and it is no mere afterthought to suggest that our adult lives are also replete with "teachers" of a less formal sort: parents and grandparents; aunts, uncles, and cousins; religious leaders, community members, coaches, and friends. A society in which more adults used these teaching opportunities to encourage young people to value diversity and increase equity would be a better one—one that did not waste human potential, but instead expanded the meaning of the "public good."

Undergraduate education could become a more intentional force, preparing adults to assume responsibilities in the next generation. Undergraduate education could better explore culture, social and educational inequality, and the development of young people. It could provide experiences that make undergraduates more aware of how culture and social status shape who they are, and how they can prepare themselves for life in a diverse society. Undergraduate education is poised on the interface of youth and adulthood, affording it enormous possibility for growing a society in which children are supported and raised more equitably.

NOTES

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2. The episode used in this chapter comes from an archive of records of an entire school year where one of the authors, Deborah Ball, taught a third-grade mathematics class. The archive consists of video records of lessons, audio tapes, digitized copies of the students' written work and the teachers' notes and plans. These records were collected through generous funding from the National Science Foundation in 1999. All names are pseudonyms, standardized across published analyses of these data, and selected to be culturally similar to the children's real names. For example, Cassandra, an African American girl, was given a name chosen from among other moderately common African American girls' names.


5. Ibid.


Mathematics Assessment of the National Assessment of Educational Progress (Reston, Va.: National Council of Teachers of Mathematics, 2000).
12. Ibid.
13. Ibid.
15. Ibid.

PART IV The Next Twenty-Five Years

Introduction to Part IV, Martin Hall

The chapters in this section look through the present to the future. Thus the chapters by Stuart Saunders and by Naledi Pandor and Nasima Badsha start from South Africa's legacy of legislated segregation and look to what has been required to address it in the interests of social justice. Pandor and Badsha's perspective is that of unfolding public policy and a series of measures intended to address student access, equity in staffing, funding, and planning at the level of the national system of higher education. Saunders, while equally aware of the public policy environment, addresses the question from the vantage point of a university leader first trying to circumvent segregationist laws and, once a democratic government was in place, addressing the need to accelerate change in the interests of redress.

Richard Riley and Judith Winston take a matching approach for U.S. higher education. Starting with the effects of the GI Bill, passed after the end of the Second World War, they track subsequent key legislation and court rulings and from this platform look forward to the needs of the new century. They argue that, given the combination of economic and security demands and the changing demographics of the American population, government cannot afford to ignore the pressing need for effective affirmative action. Michael McPherson and Matthew Smith look back to a later benchmark—the Civil Rights Act—and forward through the rhetorical dissection of the implications of Justice O'Connor's opinion in the Supreme Court's ruling.

McPherson and Smith conclude that "the greatest fraud perpetrated by opponents of affirmative action is their claim that the struggle for racial justice ended with the Civil Rights Act. The struggle that began with abolition continues today in the fight against the overwhelming inequities that still correspond to race. The principal virtue of the '25 year' statement, however it was intended, is that it provides perhaps the best opportunity since the Civil Rights Act to renew our commitment to eradicating racial disparities." Taken together, these four chapters look to a future that is grounded in the challenges of the past, and do so from the complementary standpoints of legislators, administrators, and university leaders.

The second cluster of chapters in this part looks from the past to the future in terms of race and gender—the organizing axes of identity that give definition to affirmative action and equity policies. Elaine Salo points to the dangers of relying only on the metrics of race and gender in tracking transformation. Consideration needs to be given to the cultural transformation needed to attract and retain those who are so necessary to diversify the institutional cultures...
The Next Twenty-five Years

Affirmative Action in Higher Education in the United States and South Africa

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