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Reform of Secondary Mathematics Education in High-Performing Rural Schools

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Reform of Secondary Mathematics Education in High-Performing Rural Schools[1]

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Abstract

Rural schools, like others in the nation, are enjoined to use national and state standards as the basis for educational reform. Moreover, national standards for mathematics education were established early (1989) and have been disseminated widely. Nevertheless, little is known about the dynamics of standards-based reform of mathematics in rural schools. This paper reports findings from a set of four case studies of mathematics education in rural secondary schools to provide insights into the dynamics of instructional reform. Analysis of data from interviews, observations, and documents revealed two emergent themes: (1) math teachers address calls for improvement by building on traditional practices and (2) math teachers meld traditional and reform practices.

Introduction

The National Council of Teachers of Mathematics has worked diligently for at least 15 years to articulate and disseminate standards to foster the improvement of mathematics curriculum and instruction in the US. While the need for such improvement may be difficult to dispute (e.g., Steen, 1990), the role of official standards remains problematic.

One reason that the standards are less effective than reformers might hope is that they run counter to well-entrenched views about what mathematics is and how it should be taught. Arguably, moreover, a traditional view of mathematics and mathematics education might be harder to dislodge in communities where tradition itself is honored (Howley, 2003). In fact, other approaches to improvement might have greater cultural

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resonance, and therefore greater likelihood of success, in such communities (Howley, Woodrum, & Turner, 2006).

Dynamics such as these were revealed in the analysis of qualitative data from a set of case studies of rural secondary schools with above average scores on the state's accountability test in mathematics. This paper describes what these schools were doing to "reform" mathematics education, showing that their efforts tended to focus more on changes that resonated with customary educational practices than on changes that resonated with national standards. Nevertheless, in each of the schools, highly respected educators promoted and worked to sustain reforms that conflated traditional practices with standards-based reforms.

This paper draws on conceptions of traditional, culturally resonant practice as well as on conceptions of reform pedagogy in an effort to understand how several rural secondary schools responded to calls for instructional improvement in mathematics. The researchers acknowledge that a political climate in which accountability testing is used to drive standards-based reform may intensify the potential for conflict between traditional and reform pedagogy (Howley, 2003). At the same time, they understand that such conditions might provide opportunities for educators to seek common ground between community perspectives on educational standards and those publicized by educators and policy makers (Jennings, 2000).

The standards released by the National Council of Teachers of Mathematics (1989, 2000) have had a dramatic influence on how mathematics teacher educators, as distinguished from those teaching mathematics in schools, understand the purposes and methods of mathematics instruction. These standards, moreover, have served as the

model for state-level content standards in mathematics (e.g., Joyner & Bright, 2001). Studies of the actual use of such standards in rural schools, however, have not been conducted. Existing evidence suggests that mathematics instruction in rural schools has changed little and that achievement overall is similar to national averages (Howley & Gunn, 2003). Some evidence suggests that at "higher levels" of mathematics knowledge (i.e., college preparatory high school mathematics), rural students achieve less well than other students, take fewer "rigorous" high school math courses and, in general, experience instruction that places "little emphasis on rich numeracy experiences across the curriculum" (Bottoms & Carpenter, 2005, p. 1).

Bottoms and Carpenter (2005) find that the rural schools they studied (in the South) did not hold students to "high" standards. Their notion of "high" standards, however, reflected not the NCTM vision of mathematics pedagogy and its commitment to constructivist sorts of experiences, but policy standards such as 8th grade algebra, requiring college preparatory math for all 9th grade students, and requiring four years of "rigorous" mathematics classes for all students. These represent long established versions of "high standards" and "rigor"; the desired innovation in this case is to apply them to all students.

Additional evidence of disengagement with national professional standards concerns textbook adoptions. A number of series of such textbooks have been published commercially (developed with funding from the National Science Foundation and based on the NCTM vision). Adoption rates are low, not only in rural areas (Silver & Castro, 2002) but in affluent university towns (Lubienski, 2000).

In short, there is little reason to expect strong engagement with the long-established and heavily promoted national standards. Nonetheless, the question remains: if rural schools are not following national standards, what paths *are* they following to respond to accountability pressures for higher performance? Do these paths entail changes in pedagogy or curriculum, and, if so, in what ways, under what conceptions, and to what extent?

Related Literature

What do we know about the changes in mathematics education that transpire in rural schools and districts? A small literature of prescriptions for rural mathematics education reform has existed for some time (see Howley, Howley, & Huber, 2005, for the relevant review). More recently, however, some empirical research has begun to appear (some of it sponsored by the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics).

Searching *Education Abstracts* for the years 1983-2006 simply for subject words "rural" and "mathematics" (a very wide net), we located 32 articles in published sources. Of these, just 10 were directly and unambiguously related to the findings of empirical research: 8 original empirical research studies and 2 literature reviews. The others were something else. Of these 10 works, 8 (6 empirical studies and both literature reviews) were produced by the center with which the present authors are associated (ACCLAIM). See Appendix A for more details about all 32 articles.

What does this small body of empirically relevant work tell us specifically about *rural* mathematics education for the purposes of the present study? We find two relevant themes: (1) conservatism and progressivism and (2) reform and reformism.

Conservative or Progressive Mathematics?

Bush (2005) points out that mathematics education does harbor a research strand that is abundantly relevant to rural mathematics education research: ethnomathematics. A debate prevails in mathematics itself, according to Bush, about whether or not mathematics pre-exists in nature (and is thus *discovered* by scholars) or whether it is a human invention—a cultural product *constructed* for varied purposes by humans. Views of this question tend to separate mathematical progressives (whether educationists or mathematicians) from mathematical conservatives, with the progressives favoring the view that mathematics is constructed rather than discovered.

Would rural communities actually be open to a progressive view of mathematics teaching and learning? Swidler (2005) studied two rural schools, one in which a conservative pedagogy was accepted and prized by community members, and one in which a progressive pedagogy and curriculum was. According to Swidler, the key to acceptability was community trust that students were being prepared for the next level of schooling. And this trust existed in both communities studied by Swidler—communities that were remarkably similar. Swidler's study shows that conservative rural communities *can* accept a progressive curriculum and pedagogy, and without the imposition of external pressure and intensive professional development.

A conservative sort of mathematics education, however, prevailed in a recent study of mathematics instruction provided to talented children in a rural Appalachian

district. Although the study contrasted instruction in a gifted resource room with that provided in the students' regular classrooms, it characterized the sort of instruction provided overall this way:

> Our young informants saw mathematics primarily as consisting of computation, application of memorized rules, and use of prescribed procedures. These beliefs tended to dampen the children's curiosity about mathematics while at the same time encouraging them to construe their own competence in terms, on the one hand, of competitiveness for grades and, on the other, of rigorous compliance to teachers' and parents' expectations. (Howley, Pendarvis, & Gholson, 2005, p. 148)

These studies are peculiar to particular rural locales, and weakly suggestive of an overall struggle for the mathematics curriculum in rural schools. But what about *prevalent* patterns related to rural place? The forgoing studies can't tell us much about prevalent practices.

Cogan, Schmidt, and Wiley (2001) included locale (urban, suburban, and rural) in their regression analyses of U.S. mathematics data from the Third International Mathematics and Science Study. Cogan and colleagues were interested in course-taking, type of textbook used, and time spent on particular topics. In brief, the findings were somewhat contradictory, and the authors advised caution in making judgments. More specifically, however, rural schools were found to offer less challenging courses at this grade level (60% of rural schools as compared to 80% of suburban and mid-size city schools offered "challenging" courses as defined by the study) and to provide less challenging instruction (measured as inferred topic difficulty) than suburban and urban

schools. The inferences from this study lack specificity and richness (and this lack is partly why the authors urge caution). Nonetheless, Cogan and colleagues' findings do suggest that rural schools may be more likely than other schools to practice a conservative form of mathematics education.

Reform Versus Reformism

The basis of official plans is little subject to interrogation by those for whom plans have been made, and the key difference between reform efforts and what might be called "reform*ist*" efforts is the critique of assumptions. The rural prescriptive literature on mathematics education is an example of this shortcoming in its assumption of the benefits of standards-based curriculum and constructivist pedagogy. The familiar claim is that good science justifies these assumptions (e.g., Kilpatrick, Martin, & Shifter, 2003). As yet, results of the NCTM still await adequate empirical confirmation.

Robert Bickel's work provides a uniquely salient rural critique of reformism. Bickel and colleagues showed that the agenda of standards-based curriculum and constructivist pedagogy had not improved mathematics achievement outcomes for young children in one impoverished rural state, but that quality of neighborhood, separate from the influence of socioeconomic status, did (Bickel, Smith, & Eagle, 2002; see also Bickel & Dufrene, 2001).

Bickel's team extended the analysis to include initiatives related to economic development (Bickel & C.W. Howley, 2003). These authors wrote that reformist

> …initiatives are intended to promote social and economic development in impoverished, rural areas by tying improved education in math, science, and

> technology to local needs, thereby increasing the employability and productivity of labor market participants. (Bickel & Howley, 2003, p. 85)

Questioning this assumption, these authors asked how neighborhood characteristics, jointly with "troublesome characteristics of the modem world" (p. 90) influenced the math achievement of young children.[2] Their study, comparing students in a rural county with those in a contiguous urban county, found that, all else equal, social class and placement in day care exhibited a negative influence on mathematics achievement growth. By contrast, both neighborhood quality and rural location exerted positive influences (again, all else equal). The Bickel team's work is limited to West Virginia data sets and cannot be generalized to dissimilar rural places.

Williams (2005), however, demonstrated the continuing durable effect of poverty in an international study (data from 24 industrialized nations) of rural mathematics achievement. In particular, Williams found that in 20 of 24 nations, the observed differences in rural mathematics achievement disappeared when controls for socioeconomic status were introduced. Russia was the only nation in which the negative influence of location depressed rural mathematics achievement net of the influence of socioeconomic status; in the other three cases the influence of rural locale on mathematics achievement was positive.

Structural conditions, however, are somewhat abstract. Is there any evidence of actual *resistance* to educational reform(ism) among rural people? Woodrum (2004) found ample evidence in his study of the attitudes of rural working-class families in Appalachia

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[2] Day-care quality, Head Start participation, individual and group composite socioeconomic status (see Bickel & Howley, 2003, pp. 84-90, for contextualization as "modern-world" issues). Unlike many studies, the dependent variable here was an individually administered test of mathematics achievement, administered five times to 371 subjects between kindergarten and third grade.

towards education accountability. He discovered that these families disparaged the assumption that reforms were beneficial to their rural communities or families. One parent, for instance, reported telling a child, “Don’t worry about that test. It don’t have anything to do with you or your family” (Woodrum, 2004, p. 5).

Apparently, then, both structural features and active local agency undermine reform(ist) agendas in rural areas. What about the local leadership of reform efforts? How do local school leaders engage the expectations deployed by the state? A recent study of rural high school principals leadership of math reform efforts provides some insights.

This study reported findings about the leadership of mathematics reform efforts by 20 rural high-school principals in three sorts of communities: rural-remote Appalachian, rural-remote non-Appalachian, and rural cosmopolitan[3] (Howley, Larson, Adrianaivo, Rhodes, & M. Howley 2007). The principals interviewed in this study exhibited a range of contrasting and conflicting views. Perhaps predictably, the principals had much to say about the state content standards but very little to say about constructivist pedagogy—for instance, few interviewees mentioned applications, local context, or active learning. The authors concluded that what was happening in these schools was a process of incremental change. That is, overall, the principals could be said to be taking a conservative, even skeptical, approach to reform(ism).

Methods

[3] Cosmopolitan schools were those serving suburbanizing rural districts within reasonable commuting distance of an urban center.

The research was conducted primarily under the sponsorship of the Ohio Department of Education, which sought information about a group of schools identified as “Schools of Promise.” These schools served communities with large numbers of economically disadvantaged students (40% of the school population or more), and they all were achieving relatively high pass-rates on Ohio’s accountability tests. Four secondary schools were among those studied by our team. Math achievement in these schools was considerably higher than what might be expected based on demographics alone. The schools included one 9-12 high school, one 5-8 middle school, and two 7-12 high schools. The 7-12 schools were located in Southeastern (i.e., Appalachian) Ohio, and the 5-8 and 9-12 schools—buildings within the same district—were located in the Southwestern part of the state.

The research was designed as a qualitative case study. Because data gathering was completed with a large staff of research assistants over a relatively short period of time, the research team used a structured approach (Yin, 2003). The same interview questions, observation forms, and document collection protocols were used across all of the schools. The principal investigator provided training to all of the researchers and consulted periodically with them over the six-week period during which data were gathered.

Spending approximately one week in each of four high-performing secondary schools, project researchers conducted semi-structured interviews and classroom observations. They also collected relevant documents such as school discipline policies, lesson plans, classroom tests, and other teacher-made instructional materials. Interviews included one-on-one conversations with adult informants (administrators, teachers, parents, and community members) and focus-group discussions with students.

Approximately 24 interviews (lasting from 30 – 90 minutes) were conducted at each site. All interviews were transcribed, and transcripts were prepared for analysis with Atlas-Ti software.

The study's findings were induced using an iterative process involving coding, preliminary data analysis and analytic memo-writing, recoding on the basis of preliminary analysis, and final cross-case identification of salient themes (Miles & Huberman, 1994). Initial coding of data involved identification of transcript passages, field notes, and documents in relationship to 48 *a priori* codes describing a wide range of school policies and practices (Yin, 2003). The researchers then combined related codes into five categories representing broad domains of practice—academic focus (i.e., curriculum and instruction), leadership, parent and community engagement, professional development, and school structure and culture. Next, the researchers recoded data in each category inductively. The data supporting the analysis presented in this paper all were categorized under the domain, "academic focus." These data provided insight into the curricular and instructional strategies that teachers used in order to improve students' learning of mathematics. Two researchers worked independently to code data in this category; then they shared their coding and worked together to develop a final set of broad codes. Of the 11 codes identified in this way, two—professional development and collaboration—appeared to relate only tangentially to mathematics curriculum and instruction. These codes (and the associated data) were dropped from the analysis. The remaining data supported two explanatory themes encompassing a total of 33 concepts. Cross-case analysis revealed that of these concepts, 14 were evident in the data from at least three of the four schools. The research team concluded that these 14 concepts

contributed in a salient way to the construction of the two themes, and we based our interpretation on the data illuminating these concepts. The remaining concepts differentiated schools from one another, in part on the basis of the extent to which interview responses (and to a lesser degree, observed practices) reflected the tenets of the reform agenda in mathematics education.

Findings

The two themes that seem best to explain reform of mathematics education at the four schools are: (1) mathematics teachers address calls for improvement by strengthening and rationalizing traditional practices and (2) mathematics teachers assimilate reform practices into traditional school and classroom structures.

Strengthening and Rationalizing Traditional Practices

Educators from all of the schools expressed the view that intensification of traditional practices was an important strategy for improving mathematics achievement. One way teachers intensified their efforts was by devoting additional time to tutoring students on the skills thought to be needed in order for students to perform well on state-mandated tests. Tutoring was a practice already well known to the educators in the four schools, but, in response to the threat posed by accountability testing, educators at all of the schools had developed more systematic and elaborate approaches to tutoring.

Moreover, the desire to improve mathematics achievement made them especially attentive to the widely held view that students cannot learn higher math until they master basic skills. As one high school math teacher commented while showing a copy of a math

test to the interviewer: “That’s the test I just gave them in geometry…A lot of them didn’t do as well as they should have. Basic math skills. I mean, they couldn’t do well.”

Drill on basic skills, including math facts, took place in classrooms as well as in tutoring sessions held during homeroom periods, lunch periods, and before and after school. At one of the schools teachers and students from the National Honor Society offered tutoring geared specifically toward the accountability test. According to one of the teachers who had been involved with this initiative:

> Like I did the mathematics. I stayed every Tuesday, starting September, October, and tutored for the OGT [state accountability test] or whatever math classes they have. And then Thursday nights Mrs. L. used National Honor Society students…and she staffed a tutoring session for all subjects in her room. NHS students come in and tutor after school on Thursdays for any students who want help. (PHS Interview with High School Math Teacher Grades 9-12)

At another school teachers were paid to tutor one or more students and given an extra bonus if the students they tutored wound up passing the state test. Although several teachers and administrators alluded to this arrangement, an English teacher provided the most detail:

> We offer free tutoring for the kids. And they give—and not only teachers—they give aides and classified staff—they give us a monetary bonus to tutor kids for the OGT. And if they pass it, then there’s a bonus added onto that too. And you get, I think you get to pick one kid that you want to work with, and then they assign you the others. So it’s not like you pick three kids who were one point away. But they offer, you could get up to $500 or something. You got paid for the tutoring hours;

> then you got the bonus for each one who passed too. So then it makes people more likely to give in. And again, you know, we're a poor district. (FHS English Teacher)

Teachers at the schools also assigned seat-work and homework as other ways to give students practice with basic skills and new algorithms. Students at one school complained about the amount of math homework they were assigned. At another school teachers set aside a few minutes each day for worksheets that gave students practice with skills they had learned previously. Even with older students, some of the teachers continued to use flash cards to review math "facts." These approaches reflected the prevalent belief that mathematics primarily involves sets of systematic and sequential procedures—a view most elaborately expressed in the comments of one of the math teachers:

> I try to break down the process into steps. Math is a doing-process subject; where others are learning information, learning terminology, learning words, math is a process of doing—so you have to do it in steps and stages…. I try to break down the steps and stages. And basically first you do this, next you do this and break it down into what you physically do…. You really have to take a few steps and write a few things down to complete the process. (PHS Interview with High School Math Teacher Grades 9-12)

In addition to strengthening traditional approaches, educators also rationalized them—in both senses of that word. They made the practices more systematic, and they also developed explanations intended to justify the practices. These responses were

particularly evident with regard to practices that the reform literature explicitly criticized, namely homogeneous grouping (actual tracking) and teaching to the test.

Perhaps because homogeneous grouping is so controversial, educators at the four schools spent more time discussing it than any other practice. And their comments provided evidence of a high level of ambivalence. Some teachers disliked homogeneous grouping but felt they could not change the practice at their schools:

> I don't really like ability grouping. I would rather just have a...we do ability group and I don't care for it. They group according to math achievement and I don't agree with that at all. I don't like ability grouping. And I don't understand how you can group just based on one subject and expect...because the kids feel—they know how they're grouped. And then I think it affects how they do in other classes to a certain extent. (WHS 7th Grade Teacher)

Others preferred ability grouping and were somewhat defensive in their responses to questions about it. One teacher commented,

> That is a loaded question…. The problem lies in that when you get, if you do have a mix. It is important not to spend too much time at one end or the other. I think that is what happens sometimes…. I base this on my own personal experience. When I was in class as a child, I can remember being so irritated in my middle grades because we were spending forever, trying to teach a few kids to do two-digit addition or subtraction, when I had already learned to do algebraic equations from older students, older sibling. And it was very difficult for me to sit there. And … I've thought about that and that has really been a guide as I have taught all these years. (PHS Math Teacher)

Possibly to relieve their own feelings of guilt, educators at two of the schools maintained that students were the ones responsible for ability grouping. As one guidance counselor put it,

> But then they begin to group themselves and it's according to their ability. If they are good students they will want to take college-prep and so maybe they kind of group themselves…. So by the time they are sophomores, especially juniors and seniors, they have really grouped themselves. (WHS Interview with Guidance Counselor)

According to a math teacher,

> I do feel in mathematics that there is just kind of a natural grouping that occurs because math requires a different level of interest in just, when you know when you get into high school you are able to choose what type of math you take and once that happens there is a grouping that naturally occurs at the high school level. Do you know what I mean? Are you going college prep math classes or are you going general math classes. I think that is appropriate because we all have different attitudes towards math. You are not going to make somebody love it if they don't. (PHS Interview with High School Math Teacher Grades 9-12)

Educators at the schools also talked a great deal about how they prepared students for the accountability tests, but they tended to respond with regret or defensiveness when interviewers' questions or their own previous responses implied that they might be teaching to the test. In the words of a special educator at one of the schools: "Like in math you might say they are low in angles and graphs or something and they will hit that area more when they prepare them for the test. As you know there is lots of—this is no

big secret—lots of high schools are teaching the test right now." According to a vocational teacher at another school, "I don't like the idea of teaching to the test, but that does happen—happens everywhere. And that's a human thing to do."

The practice of teaching to the test was most strenuously defended by the curriculum director in one of the districts.

> Why wouldn't you...this idea that we teach to the test...people say that like that like it's a bad thing, and if you know what the test is like and you know what the questions are going to be like, why wouldn't you want to teach to that test? If you're a classroom teacher, you don't teach for two weeks and then test something else that you didn't teach. What I tell them is…you're using released items...why do you think ODE [Ohio Department of Education] makes all that stuff available to you if they don't expect you to use it to improve what's going on for kids who take the test? So, I think that's a lot of what we do.

Educators' comments about these two strategies revealed their attentiveness to the ideology of compliance that pervaded the schools in which they worked. But they did not seem uncomfortable with the compliance orientation and, in fact, tended to create additional compliance arrangements beyond those associated with accountability mandates to structure their own work. One teacher described a standardization mechanism that the fifth grade teachers had imposed on themselves:

> Whereas in math I don't necessarily know exactly why we feel it's that important that we stay on the same page but that's what we've always done here so. I mean I know…I don't know if it's just the fact that that's something they'll use in everyday life or the rest of their life or why that is but in math we try to always

keep on the same page. (FMS 5th Grade Teacher – Teaches Everything but Science)

And almost all of the educators regarded *strict adherence* to state-adopted standards as a requirement of good teaching. One math teachers' comment summed up what we heard from most: "We all focus on the academic content standards. That is our bible." Another teacher seemed less comfortable with the ideology of compliance when he said, "The content standards are hanging over our heads. "

The educators, moreover, tended to interpret reform initiatives as compliance arrangements that could be assimilated into the traditional structures with which they were already comfortable. For example, teachers were accustomed to submitting lesson plans to their principals, so the requirement to list standards and indicators on their lesson plans hardly seemed like a major change. Some of them did express mild resentment at the increased surveillance associated with the reforms, but several expressed appreciation for the transparency and consistency that such measures encouraged.

Assimilating Reform Practices

Mathematics teachers at all of the schools had started to adopt some reform practices. Most of them framed the adoption of these practices as a response to Ohio's new content standards and graduation test. Only one teacher explicitly mentioned the standards of the National Council of Teachers of Mathematics, but comments from several others indicated awareness of some of the major ideas put forth in the NCTM standards. Moreover, comments from teachers as well as classroom observations suggested that teachers in these schools were making at least moderate use of six reform practices.

Two practices were mentioned most often: differentiated instruction and the

involvement of students in problem-solving activities. Teachers seemed to be deploying three other reform practices, but less frequently: (1) demonstrations of math concepts using manipulatives, (2) activities emphasizing the practical applications of mathematics, and (3) group projects.

Despite the fact that grouping in these schools tended to be homogeneous, teachers still seemed attentive to differences in students' learning rates and styles. Particularly at the junior high level teachers talked about using different approaches to accommodate variability in students' learning preferences. According to one such teacher,

> We gave a survey on learning styles, and there are obviously many different learning styles within just one classroom. And … a lot of times, it's difficult to…satisfy all the styles for each of the kids…. But we try to do a little bit different each day…. You can't do all eight learning styles every day, but if you can hit them multiple times throughout the year you can get their strong points… the way they learn the best. (FMS Math Teacher)

A teacher at another school also used different instructional format, letting students work in cooperative groups as an alternative to didactic instruction. She commented,

> I tend to think that kids learn from kids, just as much as they learn from the teacher. I have and it depends on the composition of the class too, that overall I at least like to do pairs or groups of 3. Usually that is how I like to arrange things. (PHS Interview with 7th Grade Math Teacher)

Most of the teachers, however, seemed to pay more attention to differences in learning rates than to differences in learning styles, and as a result, they tended to differentiate instruction by individualizing learning activities or by providing different

activities to small groups within their classrooms. Comments from two teachers illustrate these approaches:

> With the advanced also the differentiated instruction works well because … you've got the higher ability in those ones that are advancing and you give them advanced work. So that is the main thing I'll do with those that are advancing. Sometimes I'll give them enrichment—extra activities to take with them. My Algebra book has lots of those enrichment projects, almost in every section. (WHS Interview with 8th and 9th Grade Math Teacher)

> If I have kids that are really advanced, I set up a group of five or six, and I make out their own schedule and they do their own little thing…. I help them out when they need help, and I do a lot of advanced stuff like that. So again an individualized program—which takes a lot of time, but the kids love it and everybody wants to be in it. (PHS Interview with 8th Grade Math Teacher)

Differentiation along these lines seemed to make sense to teachers, perhaps because it fit in with some of the traditional approaches, such as ability grouping and individualized tutoring, that were accepted practices at their schools. One teacher's description of how she made use of the special education aide who worked in her classroom revealed the connection she saw between differentiated instruction and remedial tutoring:

> We don't want to have that person [i.e., the one with a learning disability] always go with the aide. It's just always in rotation. Whoever needs the help—if someone doesn't get it they go [work with the aide]. Sometimes it is the lower [performing students]. There's one girl in particular, and she's always in need of that extra

> support. Other than that person, I think it really goes around—who is with her or with me, because everybody has strengths even in math in different areas. (FMS 5th Grade Teacher – Teaches Everything but Social Studies)

Educators' views about the use of manipulatives also seemed to be compatible with well entrenched beliefs about the needs of students with different levels of ability in mathematics. For example, several respondents saw manipulatives as something appropriate for younger students only. According to one district superintendent, a former math teacher himself, "We introduced a hands-on type approach to math classes at the freshman and sophomore levels as compared to the traditional, somewhat college prep approach to teaching math." Others considered the use of manipulatives especially valuable for students who were experiencing difficulties: "I haven't taught Title… but I would think that the lower students would…need more hands on" (FMS Math Teacher).

Several teachers also talked about the importance of demonstrating the practical applications of mathematics to students with less evident aptitude for the subject. The two vocational educators at one of the high schools were the most outspoken proponents of this view. According to one of them,

> If you have a kid that you know is a good welder, and they're having problems with math, you say, "now, look, you've got to be able to lay this stuff out and measure and do that." And all of a sudden, "ok." So I think there's where a lot of the success has come. (FHS Industrial Arts Teacher)

Although the general tendency was for teachers to focus on the practical relevance of mathematics with their less capable students, one teacher saw the matter quite differently:

> I like to, especially with my trig and calculus class, relate everything to the real world. And I do that in my lower level classes, but maybe not so much. I would like to get them outside more. Doing more things where they can actually measure and look at the different angles that way. (PHS Interview with High School Math Teacher Grades 9-12)

Interestingly, even though the specifics differed, the general formulation was quite similar across the board. These educators subscribed to the view that there are individual differences in mathematics aptitude calling for grouping arrangements that enable the use of different methods with students of different ability levels. This formulation, while mostly reflecting a traditional perspective about mathematics instruction, nevertheless appeared to respond to the reform perspective in two ways. First, it fit with the reform view to the extent that it revealed concern for the mathematics learning of students with a range of abilities—not just those with the most talent. Second, it echoed reformers' concern to see increased variety in the pedagogical approaches used in mathematics classrooms.

Another major reform recommendation concerns the nature of the problem-solving experiences provided to students. The NCTM principles, for example, recommend that teachers use "worthwhile mathematical tasks," which are explained in the following way:

> In effective teaching, worthwhile mathematical tasks are used to introduce important mathematical ideas and to engage and challenge students intellectually. Well-chosen tasks can pique students' curiosity and draw them into mathematics. The tasks may be connected to the real-world experiences of students, or they may arise in contexts that are purely mathematical. Regardless of the context,

> worthwhile tasks should be intriguing, with a level of challenge that invites speculation and hard work. Such tasks often can be approached in more than one way, such as using an arithmetic counting approach, drawing a geometric diagram and enumerating possibilities, or using algebraic equations, which makes the tasks accessible to students with varied prior knowledge and experience. (NCTM, 2000, p. 18)

Mathematics teachers in the four secondary schools did seem to be paying some attention to the character of the problems (i.e., mathematical tasks) that they presented to students. In one school, for example, teachers were supplementing the regular textbook with a book that provided unstructured problems to which groups of students were supposed to respond. As a comment from one of the teachers reveals, however, this approach was used mechanistically ("we just go in the order of the book") rather than perspicaciously, and the way it was incorporated into the curriculum ("something we do every week on Monday") seemed to subordinate conceptual coherence to organizational routine.

> Something we do every week on Monday is the "Problem of the Week." It's not…we just go in order of the book, and it's just a question like: I have this amount…the one we're doing to do is called "Pocket Full of Change"…I have this amount of change. How many different possibilities are there to get this amount of change? And then they work in groups, we do a lot of group work, and they have to plan it out, the problem solving. And then figure it out and do a write up of how they figured it out. We do the math but we plan before doing it and then we write about it after we've done it. (FMS 6th Grade Teacher)

At another school, one of the researchers observed the kind of dialog that the NCTM principles portray as productive of deep engagement with mathematical ideas: “The teacher asks open-ended questions and explains that some questions have more than one answer. He displays data using a histogram and says, ‘What would you say based on the data? And how do you know?’” (FHS Field Notes). But at a different school, a mathematics teacher who claimed to be an active supporter of reform mathematics nevertheless expressed the view that deep engagement with mathematical ideas was reserved for eleventh and twelfth graders because with students in the earlier grades, “we need to get them to pass the test” (WHS Teacher of HS Mathematics).

Similarly, at one of the other schools a teacher who preferred to develop group projects that required complex mathematical thinking felt pressure from her students to prepare them for accountability tests by using more traditional approaches to instruction and assessment. Her comments suggest, however, that she saw pedagogy as a negotiated agreement rather than as an inevitable routine and that she intended to play an active role in changing students’ beliefs about what mathematics learning might entail:

> Today…for the data analysis, we’re making graphs. Well, we’re working on actually surveying people. So we’re going to go down to the kindergarten. They’ve [i.e., the students] set up questions, and they’re going down there, collecting their own data and they’re looking at “did I represent the kindergarten in my sample group?” and things like that. So I just feel like as much as I can I try to orient to projects, but because the kids seem so stuck on teaching to the test and things like that I have drawn back some from that. And we might do a test one week and then do a project the next week…. And it kind of helps develop the kids

> into that. So hopefully, next year … I'll be able to do more projects. Because honestly I do enjoy doing project-style teaching more than I do just looking at the book—that type of thing. I think there is a place to go up to the board and demonstrate when we first start a lesson, but once we've learned that concept, I want to reinforce that concept through a project. (FHS Math Teacher)

Summary of Findings

Overall, the data from the four schools suggest rather cautious introduction of some reform practices into mathematics classrooms in which traditional approaches still predominate. Moreover, the assimilation of these practices is heavily regulated by durable organizational structures (most notably ability grouping) and instrumental rituals of compliance (most notably teaching to the test). In addition, the fact that the teachers in these schools believe they are engaging in a reform initiative and the evident success of their efforts seems to legitimize the practice of maintaining traditional structures and rituals while simultaneously valorizing the rhetoric of standards-based reform.

Nevertheless, the prevailing rhetoric of reform—which interprets standards as a literal and exhaustive rendering of "best practice"—seems to make some room for inventive teaching. In all of these schools, for example, a sizable number of educators were attentive to and seemed appreciative of the initiatives undertaken by their most inventive colleagues. Have these dynamics always occurred in certain schools? Or has the reform rhetoric provided a new mantle of acceptability to teachers who in other times might have been viewed with greater suspicion? And what does the communal ethos of rural culture contribute to the mix? Unlike the clear constraints that ability grouping and accountability

testing place on the thinking and practices of the math teachers in these rural schools, the opportunities that mathematics standards open up to teachers seem much harder to gauge.

Discussion

Like Lubienski's study of math education reform in am affluent university community (Lubienski, 2004), this study of schools in impoverished rural communities offers insights about the dynamics of local reform action, but describes in some detail the continuities and discontinuities of related intentions. The findings suggest that local engagement with instructional reform may not involve a wholesale implementation of a specified set of practices, but rather an incremental expansion and modification of traditional and culturally resonant methods. The traditional is not overthrown, but adapted. Moreover, it seems that tradition is the bedrock of reform. As this study shows, such practices as tracking, tutoring, recitation, test preparation, and direct instruction not only persisted in these schools but seem to have grown more robust under the press of reformist agendas.

Educational reform receives momentous billing at all levels of government, and is a preoccupation of professional groups like NCTM. The local actors in this study worked hard to "implement" various directives to change—with little evident appreciation for the intellectual debates and political struggle that engendered the directives (and that will engender others in the future). One might therefore infer that reform is *least understood,* but *most practiced,* at the local level. How can this be? Two reasons occur to us. First, local conditions engender resistance to the fads of reformism. Conservative practice proves itself wise in this regard, and a broad understanding of the genesis of reforms is

not immediately important to this project of survival. Second, the actual local practice of reform little resembles the synoptic dreams of the reformists. This is inevitably so, since only locals do the things that reformists want to reform.

Insights about the importance of local conditions to the implementation of reforms imagined remote from localities (that is, state, national, or global desiderata) are certainly not new or surprising (e.g., Lipsky, 1971). Lipsky coined the notion of "street level bureaucracy," and he was concerned, in effect, with the *mistreatment* of citizens by government representatives working in difficult circumstances, particularly in accessing "services" *imposed* on their clients.[4]

Following Lipsky, it is possible to suspect that reformism does not serve rural students, schools, or local communities well. Certainly, there is no doubt that, in compulsory schooling regimes, students are non-voluntary clients. In an effort to do their jobs, teachers and administrators scramble to meet the expectations of accountability regimes, or at least to ward off the embarrassment contingent on not meeting them. The overriding concern in the schools we studied was on performance on the state accountability tests. Both traditional and "reform" practices were justified by and oriented to that performance. Does such practice constitute mistreatment of students?

Overall, we think it does.

In these schools, however, the mistreatment is not a question of lack of professionalism, a poor quality of teaching, or a peculiar deficiency of rural culture. The mistreatment is more systemic, and we shall explain, shortly, where we think the mistreatment comes in. Readers may not be convinced, but we offer an argument and a perspective.

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[4] "Non-voluntary clients" was Lipsky's phrase.

Newton's Third Law of Rural School Reform

Since at least the 1980s, a more systemic look at reformism *per se* has shown local actors pushing back against the intentions and powers of reformers and reformist agendas. James Scott's *Seeing Like a State* (Scott, 1998), a book about the 20th century's grand schemes to improve the human condition, suggests a kind of Newtonian law of reformism: Each "reform" elicits an equal and opposite reaction. On this view, a reformist system (a system sponsoring one reform after another) can properly be read as one that sponsors the undoing of what it alleges to do (while reinforcing its own existence as a system propagating "reform").

Much to the point in Scott's work, however, is respect for the circumstances in which local actors confront intruding events. By "intruding" we mean to contrast the local attachments and local commitments that constitute local meaningfulness with what Scott calls the "synoptic" ambitions of state entities. *Synoptic* means, literally, "seeing all together." A synoptic plan is one based on the notion that the planners see and know far more than local actors. In a sense this is true—they see more broadly. It is untrue in that local dynamics, meanings, and sources of resistance are dimly anticipated but remain quite unknown to planners in terms of their specifics. Reforms founder on this difference.

In recent decades, the reformist ambitions of American policymakers and professional education groups have become increasingly more synoptic. For instance, in a well-known policy study, Sashkin and Egermeir (1993) proposed the idea that reform had failed by trying to fix the parts, people, or the schools. Fixing the system was proposed as a much better idea. The new synoptic vision has prevailed since that time—a vision of standards, curricula, pedagogy, assessment, professional development, and student

"outcomes" seamlessly linked. The system will have been fixed when the vision is realized.

Synoptic vision is more a tendency than a destination, however, because all cannot be seen and almost nothing can be predicted. Especially invisible to the abstract State are the local meanings of local actors. Instead, what States are after, according to Scott, is improved *legibility* of the wide domains over which they exert increasing dominion. Scott articulates a comparatively shocking view of reformism interacting with the teleology of synoptic visions:

> In sum, the legibility of a society provides the capacity for large-scale social engineering, high modernist ideology provides the desire, the authoritarian state provides the determination to act on that desire, and an incapacitated civil society provides the leveled social terrain on which to build. (Scott, 1998, p.5)

The function of accountability-inspired examination schemes is clearly to make schools' performance more legible to the state, preferably according to a single standard. Debates about creating a national curriculum and disestablishing school boards would be seen as logical adjuncts to this program. The NCLB Act can itself be read as a synoptic reformist move: it does not single-handedly fashion a unitary system governable by a national ministry, but it moves the entire national resolutely system in that direction.

Plus C'est La Même Chose (SSDD)

What we see in the actors in this study is a kind of piecemeal appropriation of elements of a synoptic reform package. They have cobbled reformist shibboleths—problem solving, manipulatives, applications, group work—into an existing set of well-defended practices that can hardly be called "reformed," though to call them standards-

based would not be wrong. Nor would it be anything like what is usually indicated by "standards-based."

Our view is that this rural reaction is reasonable, though it does not, in our view, represent the moral high ground. The local actors gave clear signs that they believe the valued practices *work* in their schools and classrooms and that they were cautious (merely cautious) about the new practices. Perhaps ironically, the state seems to agree that traditional practices work since it designated them, specifically in mathematics instruction, as "promising" (promising, that is, as reflected in student performance).

What would the moral high ground be in our view? It hardly matters what we think, but for the sake of completion, we find that the mischief done to students, those non-voluntary clients of the abstract State, is accomplished by the very system—the reformist system—arguably intended to improve it. The constant envy and fear engendered by focusing on a few points of change in pass rates are counterproductive. Such fear and envy help keep a distracting reformist scheme—and bad habit—in place. Under these circumstances, resistance represents the moral high ground.

Finally, one might indeed ask what is rural about this study and these findings. First, the conservatism of teaching methods is shown in this rural study not to be the impediment to decent schooling that it is usually claimed for it. It's possible to argue that rural schools are not deficient on account of the natural cultural conservatism of their communities. Second, such findings suggest the possibility that rural educators can respond better to reformist impositions by recognizing more clearly what the system that sponsors them is up to. That system exerts a forceful interest in improvement, but overall improvement pleasing to the abstract State may not constitute a benefit for any specific

rural community, and overall such use of force may be counterproductive. On Scott's view, though, the system is up to something else: its own longevity. That's a goal to be undermined, and in this light it is quite interesting that the rural voice has spoken so clearly in recent years in complaint of NCLB (e.g., Dillon, 2003, Jimerson, 2002).

The second rural point of note is that much of James Scott's anthropology has been conducted in rural areas of the world, and his theory of resistance to synoptic reform plans is grounded in rural experience. Arguably, however, because rural experience tends to place traditional practice at the core of meaningfulness, a conservative impulse often serves as the engine of resistance. In a sense, though, reformism played out over a long period of time can subvert, as seems to be the case with rural schooling, the simple dynamics of action and reaction. With each iteration, enacted reform creates an amalgamated practice that equates neither to tradition nor, certainly, to reformist dreams.

This amalgam nevertheless stands in the place of tradition when it is pitted against the *next* set of reforms. Thus, for example, age-grade placement, which was an urban reform foisted on rural schools was upheld as tradition several generations later when reformers began recommending innovations such as multi-age grouping and cooperative learning. Resistance enacted as the defense of age-grade placement did not properly define a rural interest in schooling but simply served to register a rural complaint against a subsequent urban intrusion. Meanwhile, both the intruding reform and the practice upheld in defense of tradition served as instruments of the state's desire to make local practice increasingly more legible and, hence, malleable.

Portraying rural schools as reactionary on any terms then fueled efforts to close them, consolidate them, and remove them from local communities. These "successful"

reform ultimately helped disable communities' ability to understand, let alone advocate, the traditions that animate rural community life, not just in the past, but far more critically *in the future*.

Considering this self-defeating teleology, what might we mean by saying that resistance represents the moral high ground? First, we suspect that the impulse to resist heightens awareness of the power relations that determine both the real and the apparent terms of the contest. We have seen such awareness shape a common purpose in communities where educators and families join forces to fight a proposed school closure. Second, and we have seen this much less often in our own experience, the impulse to defend against intrusion seeds concerted efforts to reclaim what is meaningful from a lost rural tradition. Examples of this generative form of resistance include the cultural restoration sponsored by the American Indian Movement, some African projects to rekindle indigenous educational practices in opposition to the dysfunctional vestiges of colonialist schooling, and perhaps also the work of US educators and community members who seek explicitly to tie learning experiences to the rural places where students and their families live.

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Appendix A 2007 AERA Paper

32 articles on rural mathematics education (from Education Abstracts, 1983-2005)
Search strategy: rural (subject) + mathematics (subject) [no date limit]

R=Empirical Research; RA=Research Agenda; L=Literature Review; E=Evaluation;
P=Practitioner Piece; T=Theoretical Essay; IE = Indian Education; X=redundant
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