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Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics

Representing Rural Context in Doctoral-Level Math Education Courses
A Guide for Mathematics Education Professors

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February 2005

ACCLAIM's mission is the cultivation of *indigenous leadership capacity* for the improvement of school mathematics in rural places.

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Foreword

The ACCLAIM doctoral program in mathematics education combines courses in mathematics, mathematics education, and rural education. The combination is potentially rough on students, who may struggle to extract a coherent intellectual project from their coursework. No other education doctorate (not one that we working in the program have seen, at any rate) requires such breadth from students.

The injunction to encounter this difficulty cannot be left to students as their lonely work. This occasional paper is the outgrowth of a "task force" established to help math education faculty join the struggle. The charge to the task force left for later a similar mission to mathematics faculty; however, anyone teaching in the program will benefit from reading this guide.

Paul Theobald led the group and wrote the first and revised successive drafts resulting from the conversation among members. These members included Jim Schultz (co-director with me of the Center's research effort here at Ohio University), Tom Cooney and Larry Hatfield (both of the University of Georgia), Bill Bush (University of Louisville and Center project director), and Robert Mayes (West Virginia University, and a Center co-PI with special responsibility for the second ACCLAIM cohort). I lurked around the edges of the work. The idea for the task force, incidentally, surfaced at one of the regular meetings of the Center's management team, where substantive concerns receive concerted attention.

The management team believes the considerations evident in this paper could be helpful to others working to cross disciplinary boundaries, and not just in "rural mathematics education." Calls for such crossings are persistent for good reason:

education, properly speaking, is about widening, not narrowing one's intellectual horizon. This seems to have been news to some people in the 20th century, with its fixation on expertise, but in fact, people who took seriously the ideal of a liberal education—one with thinking at its center—have held this notion quite persistently for thousands of years.

Dissatisfaction with the "factory model" of schooling and the prevalence of "constructivist" views of learning have helped bring the old ideal into new focus. Of course, a big difference between the old and new focus concerns the identification of those for whom thinking is deemed suitable by those who take charge of such matters. Today, more people respond that it is suitable for everyone, and not just for future stockbrokers attending Ivy League colleges. It seems a reasonable commitment for a democratic nation.

In the summer of 2004, Aimee Howley and I together taught the second ACCLAIM cohort their first rural education course, and we struggled to make connections to mathematics education and to mathematics for our students. We were very pleased to quote Newton and Liebnitz to them, on the nature of knowledge and being. Students, perhaps, were happy to encounter their old friends, the competing creators of the calculus; and the students seemed surprised to learn that these supposedly practical men were as concerned with "epistemology" (knowing) and "ontology" (being) as their instructors. Newton and Liebnitz did struggle brilliantly, if quite as inconclusively as other humans, with these matters. The point is that epistemology and ontology profoundly treat *what mathematics is* and *what it means*, and not just what it does (or worse, the nifty but inevitably limited algorithms for how it does what it does so

very surely among the artifacts of human knowing).

Such “profound” connections nonetheless remain rather superficial without a community of discourse—people who read and write and talk about this stuff and who struggle to practice what they profess (i.e., preach). The Center is working to build such a community, and our students are a big part of the emerging community. We have a lot to thank them for, their fellowship in this matter (and this mindfulness) at the center of the Center.

Craig Howely
Athens, OH
February 24, 2005

Representing Rural Context in Doctoral-Level Math Education Courses

This short paper is designed to serve as a kind of primer for professors interested in thinking through ways to build a rural dimension into mathematics education courses in the interest of squarely addressing the vision and mission of ACCLAIM. Few words, therefore, will be deployed in the interest of establishing an intellectual warrant for the assumptions and assertions embedded in these pages. In fact, all that will be said in this regard is that 1) the ascendancy of what is loosely referred to as "constructivist learning theory" over the past decade clearly elevates the role of context in the development of human understanding. In other words, if you want students (pre-school through doctoral level) to achieve at high levels, the insertion of context is currently seen as critical by the great majority of the world's cognition theorists. And, 2) whether or not one views mathematics (or any other school subject) as value-neutral, the sum total of a K-12 school experience still serves as enculturation into a larger society. In that society, former students will play, minimally, a political and an economic role, regardless of whether they ever take a job or cast a vote.

This second point suggests that even if you believe the ultimate goal of formal education must be something more than learning for learning's sake—that it must in some way be directed by our best thinking about what constitutes preparation for work, for the political sphere, or for life generally, context remains critical to the project. For the worker who makes decisions out of context will soon be out of a job. And for the citizen shouldering the burden of democratic government, context is the largest single

intellectual vehicle for assessing the degree and quality of justice generated by political decisions. In other words, whether we want good workers, responsible citizens, or both, an education premised on the consistent elevation of contextual circumstances is most likely to get us where we want to be.

Probably the chief attribute of context related to learning is that it provides the reason, or the motivation, for the effort involved. Knowing that learning will increase my understanding of the circumstances that surround me and my world increases my motivation to learn. A second attribute is that context opens up a variety of intellectual avenues for looking at problems from multiple perspectives—an enriching condition that works catalytically on the development of understanding. Still another attribute of context is that it helps learners recognize that knowledge can be used for good or ill, thus outfitting them better for the political role they inherit by virtue of living in a democracy.

This is not to say that mathematics lacks disciplinary beauty or symmetry disconnected from its considerable utilitarian value. Further, this is not meant to suggest that the only route to student engagement in mathematics is through the intellectual leverage it can create over life's circumstances. But recognizing the utility of mathematics is a huge first step toward encouraging its use.

This is typically done in one of two ways. The most common, and the most likely to be included in mathematics school books, generally entails demonstrating what mathematics can do for everyday life: "Big Macs cost $2.50. Johnny has $5. How many Big Macs can Johnny buy?" Or, "Johnny's gas tank holds 10 gallons. His car can go 200 miles on a full tank of gas. How many miles to the gallon does Johnny get?" These examples speak to students in virtually all locales. But they are meaningless questions,

the answers to which students have no particular desire to know—certainly not while seated in a school building.

The other approach for illuminating the utility of mathematics is to identify something students want to know and then guide their exploration and their embrace of mathematics toward that end.

But How is it Done?

The "how" of inserting context is discussed most cogently in literature loosely labeled "place-based."[1] The essence of place-based curricular theory is that language, history, art, music, science, and mathematics can be found in all places, and that students dwelling in a particular place possess extensive experiential "data" that can be brought to bear on concepts embedded in traditional school subjects.

In theory at least, the effective teacher introduces concepts by connecting them to recognizable circumstances affecting a place. The result is that developing an understanding of the concept comes easier to students, aiding the "amount" of learning. But it also yields greater intellectual leverage over the contextual circumstances, aiding education as it seeks to prepare studnets for work and for democratic participation.

The ACCLAIM project presents an interesting set of circumstances, for the

[1] What follows is a small sampling of "placed-based" resource materials. Gregory Smith, "Place-based Education: Learning To Be Where We Are," *Phi Delta Kappan* 83 (2002): 584-594; Philip C. Dolce & Rubil Morales-Vasquez, "Teaching the Importance of Place in the World of Virtual Reality," *Thought and Action* (Summer 2003): 39-48; Toni Haas & Paul Nachtigal, *Place Value: An Educator's Guide to Good Literature on Rural Lifeways, Environments, and Purposes of Education* (Charleston, WV: ERIC, 1998); Paul Theobald & Jim Curtiss, "Communities as Curricula" *Forum for Applied Research and Public Policy, 15* (Spring 2000): 106-111; David Orr, *Earth In Mind: On Education, Environment and the Human Prospect* (Washington, DC: Island Press, 1994); Craig Howley & Hobart Harmon, *Small High Schools That Flourish: Rural Context, Case Studies, and Resources*, (New York: Rowman and Littlefield, 2000).

students in the doctoral program come from rural backgrounds and they are committed to their studies so that they may personally serve the interest of mathematics achievement among the rural residents of Appalachia. Given these circumstances, it would seem desirable to embed doctoral-level mathematics education instruction in a rural context. The trick is to connect the subject matter of traditional math education (at the doctoral level) to the rural circumstances that these doctoral students share. The complexity of rural dynamics opens up a myriad of possibilities for the application of mathematical knowledge and thus the potential for the development of mathematical wherewithal. So I'm operating from the assumption that the professors called on to teach by the ACCLAIM directors are well-steeped in mathematics education content but are, perhaps, more likely to be lacking in appreciation, understanding, or both of the rural context. Thus the perceived need for this "guide."

The Rural Context

The first thing it is useful to recognize is that the dominant culture in American society has defined "rural" as a condition closely associated with backwardness or even outright ignorance. It doesn't take a great deal of reflection to recognize this circumstance. Think about the *Beverly Hillbillies* and other such sit-coms or movies designed to generate laughter at the expense of rural people. Recall, too, that one of the major networks was reported in to be developing a *Beverly Hillbillies* reality show—where "real" rural families would be plunked down in Beverly Hills so that we can watch them fumble through their new urban lives.

Furthermore, rural America has typically been the site for the nation's most

extractive economic enterprises: farming, fishing, lumbering, and mining. These industries have typically generated wealth for non-rural owners. Appalachia has experienced this legacy most severely, but as a result of this dynamic rural America as a whole holds a larger proportion of Americans living in poverty than any other population sector, including inner cities. These circumstances suggest that math educators must consciously attend to NCTM's first principle: equity. The large percentage of rural poor means that math educators must tailor mathematics curriculum and instruction in ways that will resonate with poor rural children. In other words, they must provide the "further assistance" called for by NCTM.[2]

Doctoral students focusing on mathematics education for rural students should examine all NCTM principles in light of what "being rural" means in the lives of students. The equity principle is an obvious concern, but how about the curriculum principle? The teaching principle? Learning? Assessment? Technology? It turns out that these principles are inextricably connected to one another. For example, a rural school's mathematics curriculum must be coherent, focused on important mathematics, and well articulated across grades. But in order for such a curriculum to be learned, it must be effectively taught. In mathematics, perhaps more than in any other traditional school subject, learning needs to reach the level of understanding if it is to have the greatest possible impact on individual lives. This is done, according to NCTM, by "building new knowledge from [rural] experience and prior knowledge."[3] All NCTM standards, from number and operations to representation, can be examined in light of rural circumstances in the interest of designing lessons informed by the rural experience.

[2] National Council of Teachers of Mathematics, *Principles and Standards for School Mathematics* (Reston, VA: National Council for Teachers of Mathematics, Inc, 2000), 13.
[3] Ibid., 371.

Mathematics education professors who choose to embed their particular course in a rural context should think about ways to stretch their students to consider why particular lessons in mathematics are of value to rural students. Further, given the nature of rural experience in the United States, as determined by our history, geography, politics, and economics, among other variables, professors should encourage their doctoral students to consider the value of mathematics to rural students on four different levels.

The first is ***utility***, and it is also the most obvious and, perhaps, the easiest to see and consider. How is a full range of mathematical wherewithal useful to rural students? If we successfully stretch doctoral students to consider this question, they will go considerably beyond the use of algebra to calculate the cost of weight gain for steers and heifers. They will see that mathematics can be a tool to explain why Wal-Mart is deadly for local merchants, why soil erosion jeopardizes the long-term viability of rural economics, why a diminished property tax base makes for inequitable education expenditures across the spectrum of our nation's schools. In short, asking doctoral students to consider the value of mathematics for rural students from the standpoint of utility will help them see how they can become a catalyst for greater intellectual leverage over the circumstances negatively affecting rural places.

A second level on which to consider the value of mathematics to rural students has to do with what we will call, for lack of a better word or phrase, the recognition of ***connections*** in the rural environment. While students of higher mathematics often see the aesthetic appeal of symmetrical balance in mathematical operations, this appeal is considerably less obvious for most P-12 students. This can be successfully addressed,

however, by connecting the mathematical operations to the patterns that exists in the immediate rural environment. This can be done for both the natural environment—as in the calculation of the slope for a watershed—and in the man-made environment—as in the geometry of a round barn. The point here is that doctoral students can be stretched to consider the value of mathematics to rural students in terms of their aesthetic development and, in turn, their appreciation for the place where they live.

The third level has to do with finding value in what mathematics can do for the ***self-image*** of rural students. As a result of larger cultural forces alluded to earlier, rural students going off to college report that they don't feel as prepared as their urban and suburban peers (as reported annually by the Higher Education Research Institute at UCLA). And, indeed, success or failure in freshman mathematics courses is currently considered the largest variable affecting college retention rates. Doctoral students should be asked to consider the value of mathematical knowledge in terms of how it can help counteract the effects of negative cultural stereotypes connected to rural living.

The final level at which to consider the value of mathematics to rural students has to do with what it can contribute to a ***cultural renewal*** defined by healthier, more humane, and more just treatment of the rural environment and the people who struggle to make a life and living there. At this level, doctoral students should be asked to see the value of mathematics as similar to the value of art, literature, history, or music—indeed, virtually all of the traditional school subjects. That is, they should be asked to consider the value of mathematics in terms of the insights it produces concerning the human condition. It is useful, it is beautiful, it can build confidence in a person's ability to get on in the world, but it can also contribute to how we are with one another—to whether we

behave in full recognition that our behavior affects others. In this way it affects the quality of culture generated by human choices. Our goal should be to push doctoral students to recognize that the use of mathematics—as well as recognition of its beauty, its contribution to a positive self-image, and its affect on cultural renewal—will be fully realized by rural students only to the degree to which mathematics curriculum is viewed through a rural lens. Said another way, mathematics will only come alive for students if it illuminates the world they inhabit.

Searching For the Value of Mathematics

What does all of this mean for my doctoral course in mathematics education? In some ways, it doesn't have to mean much. There are obvious curricular expectations in a mathematics education doctoral program, and these should not be compromised. Perhaps the best way to acknowledge the wisdom inherent in embedding doctoral-level mathematics education in a rural context is to set a kind of thematic tone for the course, or general orientation—perhaps through a series of assignments, or perhaps merely through the "course overview" described on the syllabus—and then ask the doctoral students, who we know to be intimately familiar with rural circumstances, to explore ways to put the rural context into the course. They should be asked to do so, keeping in mind the four levels at which mathematics can be of value to rural students.

Each general area within a mathematics education curriculum likely lends itself to a slightly different course tone or orientation. For example, a course dealing with learning and assessment could perhaps be framed as the vehicle for examining the role played by context in the development of understanding, as well as an opportunity to

examine the ways that sophisticated assessment can measure the impact of contextual embedding. In other words, a tone for the course could be set with statements such as these: *In this class we will seek answers to fundamental questions about the nature of learning, the nature of learning mathematics, and the nature of learning mathematics of value to rural students. We will also seek to identify assessments strategies that inform curricular and instructional decisions designed to promote the same.*

A mathematics education curriculum course could be framed as a vehicle for exposing a full range of rural conditions, the understanding of which is made more complete by wielding mathematics. Students could be asked: *What can be examined mathematically that would produce value at the four levels?* This course could be a venue for matching rural circumstances with age-appropriate mathematical concepts and operations—everything from graphing the age of headstones in the graveyard to doing algebra to determine the rate of weight gain in cattle to analyzing the impact of Wal-Mart on local job loss or gain.

A doctoral-level course dealing with mathematics instruction could be framed as the vehicle for exploring the suitability of instructional approaches that mesh well with the nature of the mathematical concept or operation to be learned, as well as with the selected rural circumstances the mathematics will illuminate. In other words, the course theme could be the identification of instructional methods that will advance context-embedded mathematical learning.

Encouraging doctoral students to think through how to prepare pre-service teachers could be done in a course framed as a vehicle for creating an introduction to place-based curriculum and instruction. In other words, the doctoral students could be

asked, collectively, by way of introduction to the general course orientation: *If you wanted to prepare the very best mathematics teachers possible, and you believed that a piece of this included developing the wherewithal to embed mathematics lessons into a local context, how would you do it? What would you determine the pre-service teachers would need to know and be able to do?* It should be evident that an answer to these questions must take into account what it is about mathematics that the doctoral students believe is of value to rural students.

Last, a research seminar is a great place to consider the extent to which research dealing with mathematics education is applicable or generalizable to students living in rural locales. The general orientation could frame the course as a vehicle for in-depth exploration about the nature of research, what it can and cannot do, and what it can reveal about the rural condition as it relates to learning mathematics. The course could be framed as a chance for doctoral students to ferret out for themselves what sorts of research designs will truly explore rural mathematics education as opposed to those that will merely explore mathematics education delivered in a rural school.