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An Initial Research Agenda for Rural Mathematics Education

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ACCLAIM's mission is the cultivation of *indigenous leadership capacity* for the improvement of school mathematics in rural places. The Center addresses the mission through efforts to (1) understand the rural context as it pertains to learning and teaching mathematics; (2) articulate in scholarly works, including empirical research, the meaning and utility of that learning and teaching among, for, and by rural people; and (3) improve the professional development of mathematics teachers and leaders in and for rural communities.

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Funded by the National Science Foundation as a Center for Learning and Teaching, ACCLAIM is a partnership of the University of Tennessee (Knoxville), University of Kentucky (Lexington), Kentucky Science and Technology Corporation (Lexington), Marshall University (Huntington, WV), West Virginia University (Morgantown), the University of Louisville, and Ohio University (Athens).

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An Initial Research Agenda for Rural Mathematics Education

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Abstract

Responding to the need for research in rural mathematics education, three investigators develop an initial research agenda in this area. Because this development is perhaps unique, the investigators envision the utility of this initial agenda in terms of both product and process.

Drawing from 190 questions from multiple sources in mathematics, mathematics education, and rural education, the authors develop 12 questions and 48 illustrative subquestions as an initial agenda. The questions are developed both to indicate relevancy as research and to indicate dispersion among possible variations of specific questions. Four recommendations are made about the process of developing these questions involving cross-disciplinary collaboration, technical processes, and applications.

This manuscript is an outgrowth of the current work by the research initiative of the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM).

Introduction

In an editorial calling attention to the lack of research in mathematics education in rural settings, the editor of the *Journal of Research in Mathematics Education (JRME)* noted "there has been precious little research on teaching and learning mathematics in these places," although one in five children (over 12 million) reportedly lived in rural areas (Silver, 2003, p. 2). He disclosed that *not a single manuscript* out of 400 submissions during his term as editor had dealt explicitly with mathematics teaching and learning in rural settings. This paper responds to this need by identifying timely and pertinent research questions. The authors represent a team of mathematics and rural educators based in a national center dedicated to rural mathematics education research and improvement. The work, however, draws on field-based work from at least 10 years of practical experience.

Overview and Rationale

This study grew, in particular, out of the work of the research initiative of the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM), one of the National Science Foundation's (NSF) Centers for Learning and Teaching (CLT, see CLTNet, 2004). The centers share common goals and yet have different foci, with two centers addressing the intersection of mathematics education and rural education. As the name suggests, the thrust of ACCLAIM is in a four-state Appalachian region, while the CLT West addresses similar work in Western regions of the nation.

The creation of two centers to research mathematics education in rural settings surfaced some anxieties about how to organize a new field of inquiry (Howley, 2002, p. 25). For instance, in the funding negotiation phases of the project, NSF raised concerns about venturing into a "previously undefined area." To date, nonetheless, ACCLAIM has published 31 formal papers on its Website, published 7 issues of its online journal, held 2 research symposia involving national leaders in mathematics education and rural education, and conducted research sessions at annual meetings of national and international professional organizations, including the National Council of Teachers of Mathematics (NCTM), the National Rural Education Association, and the American Educational Research Association. Several peer-reviewed journals have accepted rural mathematics education articles from Center scholars.

Justification for these efforts is supported by the previously cited *JRME* editorial and by the funding of two CLTs in this field by the NSF. Moreover, the effort is consistent with the view presented by James Hiebert for the National Council of Supervisors of Mathematics. In speaking of the work of the Trends in International Mathematics and Science Study (TIMSS), Hiebert stressed the importance of honoring mathematics teaching as a cultural activity. Yet relatively little attention has been given in mathematics education to the rural culture (Schultz, 2002). In an interview with the *Rural Mathematics Educator*, the NCTM President observed, "Equity is the overriding priority in every effort of the Council. It is the first principle and one that influences all the Council's activities. Certainly research is needed to determine the factors that influence achievement in rural settings" (Seeley, 2004, ¶ 9).

The authors envision applications of this paper both in terms of product and process. The product includes an extensive list of 190 potential questions proposed by a variety of practitioners and researchers, and assembled from various sources by the authors, reduced to a list of 25 most relevant questions (see the sections devoted to relevant literature and methods for details), and finally reduced to a list of 12 thoroughly revised questions, illustrated in each case by 4 more narrowly focused sub-questions.

The process described in this article provides one exemplar of researchers in different fields collaborating to clarify research needs in a new discipline. Before the establishment of ACCLAIM, the three authors would have been clearly identified as two mathematics educators and a rural educator. But during three years with the Center, all three have been actively and regularly involved in crossing disciplinary boundaries, such as teaching ACCLAIM doctoral courses; developing a research Web presence; creating a new academic journal; making research presentations; organizing research symposia; designing and conducting research; and reviewing articles and proposals in the intersection of mathematics education and rural education.

Collectively, the authors' extensive experience includes teaching in rural schools; conducting professional development in rural schools; publishing widely in mathematics education and rural education; holding executive editorial roles for national publishers; advising and directing dissertations; creating and directing federally funded rural projects; writing mathematics textbooks at all levels; and co-authoring the 1989 NCTM *Curriculum and Evaluation Standards for School Mathematics*.

This article, in short, offers an authoritative response to a now well-defined need for a large underrepresented group in mathematics education. The remainder of the paper

is structured as follows: Research on Rural Mathematics Education, Methods, Results, and Discussion.

Research on Rural Mathematics Education

Although the field of rural mathematics education did not exist as a domain of research prior to 2001, substantial improvement efforts in mathematics education had been undertaken among rural schools. These efforts included a variety of reform programs, which had most recently included the Rural Systemic Initiative (RSI) funded by the National Science Foundation. With the RSI experience it became clearer to some observers and participants that research in math education had overlooked the particular interactions of culture, policy, pedagogy and place that prevail in rural schools and communities. Specific inquiry into the conditions and dynamics that might strengthen the odds favoring improvement efforts in rural places seemed necessary.

Extant Research Prior to 2001

The authors surveyed the extant literature prior to 2001 in order to assess the baseline research against which progress of the Center's research efforts might be calibrated. The domain of relevant literature was conceived as the intersection of research-related work in mathematics education and rural education, construed most narrowly as reports of research (not evaluation) studies. The researchers did, however, also examine the evaluation and project-description literatures.

Mathematics education has a huge literature, but the quantity devoted to rural issues is meager indeed. Between 1985 and 2001, the Educational Resource Information

Center (ERIC) indexed more than 5,000 resources as mathematics education research reports as *Set 1*, under the following descriptors:

> {Elementary school mathematics OR secondary school mathematics OR mathematics education OR mathematics curriculum OR mathematics teachers OR mathematics achievement OR mathematics materials OR mathematics tests or mathematics skills}

To represent the rural literature of interest, the researchers established *Set 2* as follows,:

> {Rural schools OR rural education OR rural-urban-differences OR rural-to-urban-migration OR rural areas OR non-metropolitan areas}.

While Set 2 contained about 3000 resources, the intersection of the two sets contains just 47 works indexed as research studies. Of the 47, however, 27 were also indexed as evaluation reports, and inspection confirmed a primary evaluative purpose; they were eliminated from the relevant literature. This left 20 properly identified research studies in the intersection.

Twenty studies about rural mathematics education may not constitute a recognizable national disgrace to many observers, but it is a surprisingly inadequate effort considering the fact that 30.3% of students attend schools located in rural places and small towns, and that 41.9% of schools and 63.7% of school districts in the United States are located in rural areas and small towns (Hoffman, 2002; National Center for Education Statistics, 2002). A field that understands the influence of context cannot honorably continue to ignore rural issues.

Upon closer examination, the quality of this pre-2001 literature representing mathematics education in rural settings is revealed by these typical shortcomings:

1. The studies use samples from rural schools, but take no account of context;
2. The studies provide scant descriptions of the rural settings, and often none at all;

3. The studies conceptualize topics and events as immune from contextual influences;
4. The studies fail to address or even define recognizable rural issues;
5. The studies report findings that have no connection to the rural contexts of the studies, and
6. The studies (therefore) draw no conclusions relevant to rural practice, policy, or research.

Such flaws negatively define expectations for work that would attend better to the contextual features that influence the meaning, the utility, and the form of mathematics education in the American countryside. (We found similar oversights in the evaluative and project-descriptive literatures identified through ERIC.)

In addition to the literature indexed by ERIC, the researchers examined the dissertation literature using a similar procedure and with similar results for quantity and quality. The indexing system used with the dissertation literature is considerably less specific than ERIC's, and searches identified 117 *possibly* relevant dissertations 1985-2001. The Center has included abstracts of the 16 of the 117 dissertations on the ACCLAIM website as at least minimally engaged with context (for methodology for this selection see http://www.acclaim-math.com/resmathed.aspx). The Center identified just two of these studies as "rural intensive" in the sense that they asked questions that generated substantial rural-specific discussions and conclusions. One is available only in Chinese.

ACCLAIM's Research Efforts

Since 2001, ACCLAIM has developed as a cross-disciplinary Center whose research specialty is the field of rural mathematics education, a field it has had to invent. The research work has three simultaneous phases: (1) conceptual, (2) practical, and (3) instructional. These "phases" continue to amplify the overall mission of the Center as they unfold and interact. The discussion turns next to a brief description of these three phases.

The conceptual work arguably leads the research effort. Early in the Center's life, the management team debated and adopted a theoretical framework for the Center's research efforts (ACCLAIM Management Team, 2002). Briefly, the framework articulates a commitment to engaging the constructs of *place* and *community* in studies of rural mathematics education. This engagement is supported by an appreciation for the richness of the rural lifeworld (the largely untheorized and unexamined meanings embedded in ordinary rural life; see Habermas, 1987, for further consideration of the phenomenological construct known as the *lifeworld*). The agenda reported in this article is the result of applying the theoretical framework to a large number of field-based questions in order to develop a focused set of questions responsive to Center principles and commitments. The methods section describes the procedures used.

The ongoing practical research work has, in fact, increased the quantity of empirical mathematics education research that represents rural place as more than a setting for the study of questions not related to place. As noted previously, the output has been considerable (at least 60 products of various sorts). The products are the result of a

two-part practical strategy of shaping the research of interested colleagues – partly by soliciting manuscripts related to completed work and partly by offering modest support for planned studies. These efforts continue and are based on a pluralistic conception of research and an invitational stance toward collaboration. The agenda reported here has the potential to help focus this ongoing effort.

The instructional phase of the Center's rural mathematics education work centers on the ACCLAIM doctoral program, which recently enrolled its second cohort. The doctoral coursework includes three rural education courses taught by nationally recognized rural education scholars. The students are being prepared (but are not required) to engage rural mathematics education issues in their dissertations. The ACCLAIM Management Team anticipates that 80% or more of the students will choose to study rural mathematics education, with support from the Center's Research Initiative.

The development of this agenda thus advances the work in all three phases of the Center's research effort. The next section describes in detail the process used by Center researchers to develop the 12 questions and 48 illustrative sub-questions that comprise the agenda.

Methods

This article draws research questions posed – both explicitly and implicitly – from four sources: Papers created for and presented at the first ACCLAIM Research Symposium in November, 2002 (ACCLAIM Working Papers numbers 5 – 14 available at http://www.acclaim-math.com/resworking.aspx), other ACCLAIM working papers, the ACCLAIM framework and its companion essay (ACCLAIM Occasional Paper number

1), and the May 2001 Research Conference sponsored by the Appalachian Rural Systemic Initiative (ARSI). The original 190 questions are listed in Appendix A. Table 1 shows the count from each source.

Table 1

Sources of Research Questions	Count
First ACCLAIM Research Symposium	105
ACCLAIM Working Papers	18
ACCLAIM Framework	4
ARSI Research Conference	63
Total	190

The determination of the final 12 questions occurred in three stages. The first stage selected the questions deemed most relevant and approachable. The second stage identified the 12 most pertinent questions. The third stage reworded the 12 questions with regard to consistency and generated 4 subquestions for each.

Stage One (Questions deemed most relevant and approachable)

The researchers independently ranked each of the 190 questions using a 5-item Likert Scale according to two criteria: relevance and approachability (See Appendix A). The *relevance* criterion was a theoretical judgment based on the researcher's view of the relevance and alignment of the question to the ACCLAIM theoretical framework and ACCLAIM's overall mission. The *approachability* criterion was a practical judgment

based on the researcher's view of the degree to which the question was approachable as research; that is, the degree to which the question could be approached empirically.

The results were then combined in a single spreadsheet and z-scores were calculated to standardize for the relevance criterion across researchers. Average z-scores were then found for each item and the top 25 questions were kept. The 25 questions, sorted from highest to lowest by average standardized relevance score are reported in Appendix B. We note that questions were judged by their perceived intent rather than in terms of their exact wording.

Stage Two (Identifying the most pertinent questions)

Each researcher independently initially selected 10 of the 25 questions based on a professional judgment of the relevancy to the Center's theoretical framework and mission, in view of possible redundancy among the questions. For example, a question was not chosen if it overlapped another. Figure 1 shows the numbers of the top 10 questions chosen by each researcher.

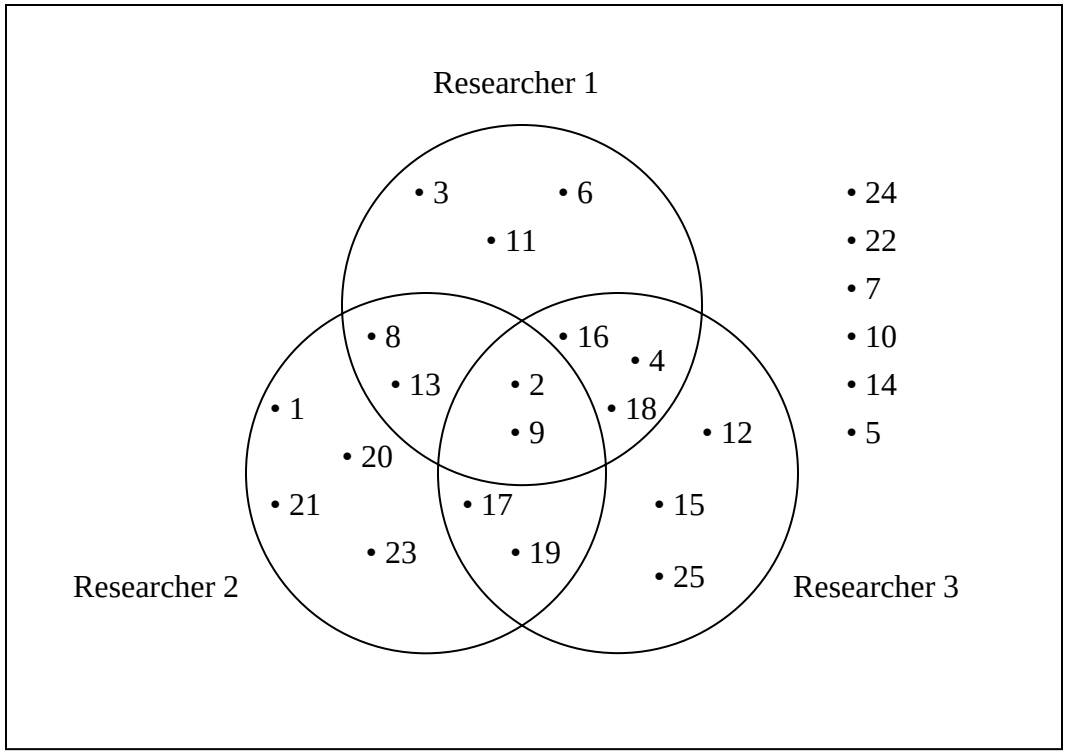

Figure 1. Top 10 questions chosen by each researcher from the 25 questions ranked highest according to average relevance (standardized).

Two of the questions were selected by all three researchers and so were accepted for a final list of candidate questions. Six questions were chosen by no researcher and they were eliminated. The remaining 17 questions were chosen by either one or two researchers.

The discussion of stage two continued with consideration of the questions chosen by a single researcher. Of such questions, each researcher was convinced during discussion to abandon two, leaving 13 in the pool, including the two selected by all (see Figure 1).

Finally, the discussion concluded with consideration of the questions chosen by two researchers. Agreement was reached to eliminate one of them, leaving 12 questions on the final list. Figure 2 shows the list of questions by number, indicating the questions eliminated. In sum, the three reasons for the elimination of 13 of the 25 highly relevant questions were: (1) low relevance, (2) clear redundancy, and (3) problematic conceptualization.

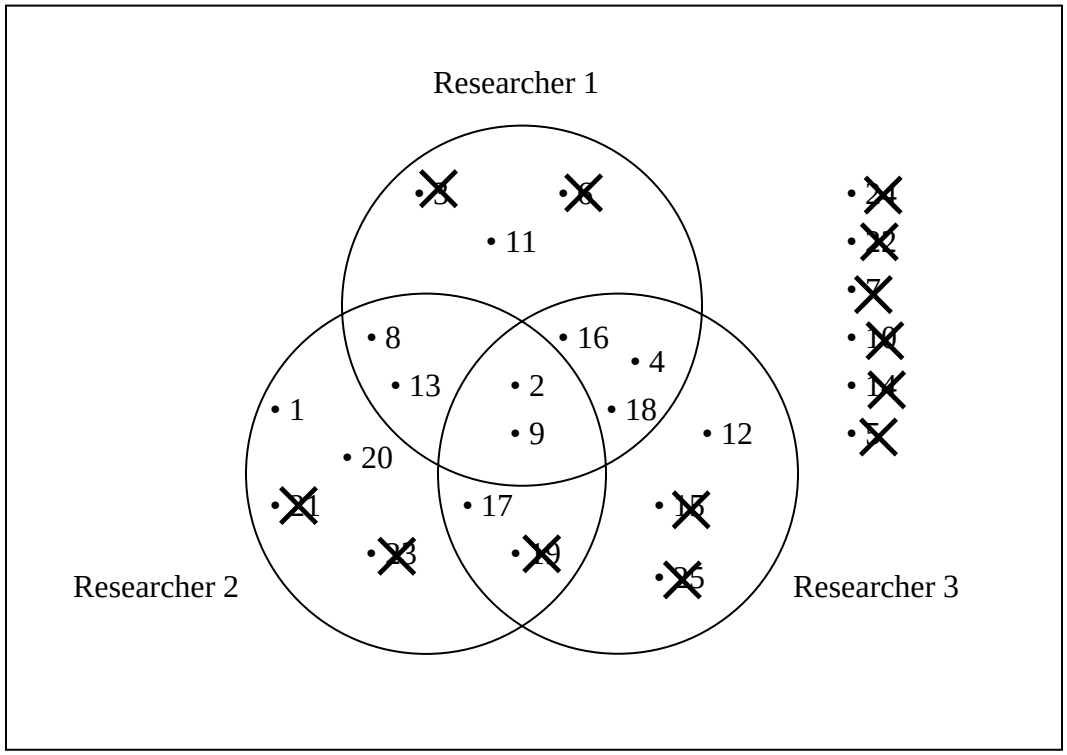

Figure 2. List of 12 candidates for rewording, indicating rejected questions.

Stage Three (Rewording and generation of subquestions)

Each researcher took 4 questions from the list of 12 based on professional experience. Questions were to be rewritten for consistency, parsimony, and empirical approachability. After rewriting, a follow-up discussion determined the final rewording of the twelve questions. The researchers then agreed upon 4 illustrative subquestions for each of the 12 questions. The purpose of the subquestions was to be more specific while showing a range of possibilities.

Results

In offering these results in this venue, the challenge for the researchers is to make the questions accessible to the mathematics education community. Some of the questions posed come from an epistemological framework that, if not unheard of in mathematics education, is at least rarely considered.

It may be observed that few of the questions that follow concern *students* directly. Instead, the questions address the relationships of *teaching*, *learning*, and *knowledge* with *community*, *place*, and *everyday life* ("the rural lifeworld"). This reconceptualization is not unlike the one used by Stigler and Hiebert (1999), in *The Teaching Gap,* in which *teaching* rather than *teachers* becomes the focal concept. With the present work, the Center takes a similar stand with respect to context, and students are implicit much as teachers are implicit in any discussion of teaching. Rather than regarding context as *separate* from students, Center scholars (with many social psychologists) view context as integral to their development. On this view, context not only surrounds human beings, it *inhabits* them.

For this reason, the Center's theoretical framework (found at http://www.acclaim-math.com/docs/Final Framework10-16-023.pdf) highlights four commitments against which the questions in this agenda were (in significant part) measured. These commitments assert that the field of rural mathematics education should

1. describe the salient relationships between mathematical knowledge and rural context;
2. examine rural schools as they serve or subvert the development of mathematical knowledge and expertise within the rural lifeworld;
3. examine hypotheses about the place occupied by mathematics knowledge in and (prospectively) *for* rural communities; and,
4. elaborate theories of, and knowledge about, "pedagogy of place" for mathematics education in rural schools.

The Center seeks to foster continuing conversation between scholars in mathematics education and rural education. Of what this intersection might consist poses a difficult problem set in itself, but one view is that mathematics teaching and learning is place-specific and, in particular, may – and perhaps should – look rather different from place to place. This collection of questions is one way the Center chooses to advance the conversation.

The 12 questions fit loosely into three broad interrelated categories: Teaching, policy, and culture. Some of the questions – and especially the sub-questions – do cross boundaries. Question 7, for example, is a question generally about policy; however sub-question 2 relates strongly to teaching. The rewritten questions have been renumbered. The number after each question in square brackets refers to the original question from which the rewritten question came (see Appendix B).

Questions Involving Teaching

1. What factors foster competent mathematics teaching in rural settings? [20]

- How does the mathematics preparation of secondary mathematics teachers in rural areas differ from teachers in non-rural areas?
- What factors influence competent mathematics teachers to devote their careers to teaching in rural areas?
- To what extent are the achievements of mathematics teachers in rural areas recognized in forms such as major newspaper articles and Presidential Awards?
- What stories serve as models of successful mathematics teaching in rural areas?

2. What conditions contribute to out-of-field teaching of mathematics in rural schools? [17]

- What are the hiring practices of rural schools with regards to hiring out-of-field mathematics teachers?
- What characterizes the practice, experience, and preparation of effective out-of field teachers of mathematics in rural vs. suburban schools?
- How do mathematics teacher migration patterns affect out-of-field mathematics teaching in rural schools?
- How does supply and demand of mathematics teachers in rural schools compare with other teachers in rural schools?

3. To what extent are mathematics instructional approaches and assessment practices consonant with the needs of rural communities? [8]

- What portion of contextual mathematics is devoted to rural settings as opposed to urban and suburban settings?
- What mathematics content is most useful to people living and working in rural settings, and to what extent is this mathematics incorporated in textbooks?
- To what extent are rural perspectives represented in the development of mandated mathematics assessments?
- To what extent do supplementary activities related to mathematics (such as visiting sites on the Internet and taking school field trips) reflect the rural experience?

Questions Involving Policy

4. How does the rural circumstance influence the dynamics of improvement in mathematics education? [9]

- What features of the rural lifeworld influence the engagement of rural communities and educators with reformed mathematics curricula?
- How are in-service efforts for teachers in rural areas different from those in non-rural areas?
- How does access to technology affect the improvement of mathematics education in rural areas?
- How do community beliefs subvert or enhance improvement of mathematics education in rural areas?

5. Why do mathematics teachers seek or remain in positions in rural schools? [12]

    - How does salary influence a mathematics teacher's decision to seek or remain in a rural school?
    - Does organizational climate differ in districts with high and low turnover rates for mathematics teachers?
    - To what extent do demographic characteristics of school districts predict stability of mathematics faculty?
    - What socioeconomic conditions influence the stability of mathematics faculty in rural school districts?

6. What is the impact of the implementation of mathematics reform efforts in rural areas? [1]

    - What are the effects of mathematics reform practices on rural students' mathematics achievement?
    - How does the textbook adoption process in rural areas differ from non-rural areas?
    - What are the challenges unique to rural areas to mathematics reform efforts?
    - What is the relationship between values held by parents in rural areas and mathematics reform?

7. How do local educators develop mathematically relevant connections with rural communities? [4]

    - How do teachers' mathematics expectations for students in rural areas differ from those in non-rural areas?
    - What do teachers in rural areas communicate to their students about the value of mathematics?
    - To what extent do rural issues influence principals' communication with parents about mathematics instruction in rural areas?
    - How do practices of school boards with regard to mathematics instruction in rural areas differ from practices in non-rural areas?

Questions Involving Culture

8. What roles do various forms of social and cultural capital play in mathematics teaching and learning in rural places? [16]

    - What differing forms of social and or cultural capital do rural working-class community members and mathematics teachers deploy in their interactions?
    - How do rural schools manage the social and cultural capital brought by students to mathematics classrooms?
    - How might forms of social and cultural capital be manifested in rural versus non-rural mathematics classrooms?
    - What messages about social class do rural mathematics teachers convey in their classrooms?

9. In what ways is mathematics education in rural areas oriented with respect to place and community? [2]

    - From a theoretical perspective, what meanings of rural place might appropriately inform mathematics curriculum and instruction?
    - How is "pedagogy of place" manifested in mathematics programs in rural schools?
    - To what extent do "place-based education programs" in rural schools engage mathematics teaching and learning?
    - In what ways do rural mathematics teachers engage the idea or reality of local community in their teaching?

10. How do school and community cultures socialize mathematics teachers in rural schools? [11]

    - What are the norms of mathematics professional practice that socialize mathematics teachers in rural versus suburban secondary schools?
    - What is the difference in the socialization of local versus in-migrant beginning mathematics teachers in rural secondary schools?
    - How does urban sprawl impact mathematics instruction in formerly traditional rural areas?
    - How do mathematics teachers in rural schools accommodate community cultures?

11. What do members of rural communities believe about mathematics? [13]

    - How do rural adults describe their experience of school mathematics?

- In what ways do rural working-class adults mathematize their encounters with situations in everyday life?
- What conceptions of numeracy do rural working-class adults hold as opposed to rural middle-class adults?
- How do individuals' conceptions of numeracy vary among differing types of rural communities?

12. What is the adult experience of mathematically talented rural students? [18]

- What influences shape the aspirations of more mathematically talented rural students and less mathematically talented rural students?
- Are there differences in the life trajectories of mathematically talented rural and mathematically talented non-rural students?
- What influences out-migrant young adults who were mathematically talented students in high school to return to rural areas?
- What advantages or disadvantages associated with their rural backgrounds do mathematically talented rural students who attend college face?

Discussion

According to critique offered by rural education scholar Alan DeYoung (1991), the lack of research interest in rural mathematics education is a direct outgrowth of the prevailing academic reward system. DeYoung notes that the academy embraces two conflicting modes of operation that shut out rural issues. For centuries, universities have privileged theoretical over practical intellectual work (with arts and science disciplines receiving highest status). More recently, however, university agendas cleave to funding streams; academics who secure large grants are privileged to set departmental or college agendas.

Following DeYoung's critique, the Center's focus on rural mathematics education is happily enabled by both these contradictory tendencies. Mathematics is arguably the longest and most venerated member of the arts and sciences pantheon. Although education, as DeYoung notes, is not even permitted to stand in the pantheon's portico, it is nonetheless widely appreciated that mathematics must be taught: no one is born

speaking algebraic equations. This widely appreciated insight serves to justify funding for a wide range of work in mathematics education, and rightly so. In this case, a constructivist climate renders the importance of context practically self-evident, and hence the academy has, for the time being, found it possible to recognize the existence and influence of rural context.

Those involved in this recognition are uncertain how long the privilege of doing this work can last. Center participants, including researchers, doctoral students, graduate assistants, and ACCLAIM scholars feel a certain urgency in promoting not just their own work, but in promoting this domain of inquiry among others. Just as 30% of students attend school in rural places, it seems that at least an equal proportion of researchers and practitioners in mathematics education and in rural education and would be susceptible to the considerations and opportunities offered by the preceding questions and, more generally, by the work of the Center.

These 12 questions by no means exhaust the domain of study. For that reason, we dub them an "initial" agenda. Indeed, a list of questions itself hardly comprises an agenda, but together with the Center's theoretical framework (and longer supporting essay) and its program of doctoral study, a research agenda is clearly visible. This paper concludes with a consideration of recommendations for the extension of the agenda offered here to future work, both in the Center and elsewhere.

Recommendations

These 12 questions (and their 48 illustrative sub-questions) demonstrate to a global audience the important intellectual and practical substance to be addressed in rural

mathematics education studies, in particular. But they demonstrate several other matters as well, including recommendations about cross-disciplinary collaboration, technical processes, and applications. Assuming that the research questions presented above, along with the symposia, papers, presentations of ACCLAIM, constitute an "existence proof", we offer several recommendations for the generation of research questions in a new field.

Cross-Disciplinary Collaboration

First, they have something to say about the largely uninhabited territory of cross-disciplinary collaboration. The Center has built a network of collaborating rural education and mathematics education scholars. The participants have engaged a number of exploratory works together, usually with the view of better understanding one another's intellectual and academic projects. They have created symposia together, collaborated on designing and conducting studies, and, even disputed the terms of collaboration and the nature of matters on which to collaborate. Early on, for instance, the name of the intersection between the two fields was an obvious point of contention. Was it "mathematics education in rural schools" or "rural mathematics education?" The debate was not about semantics; it was about conception of the work to be done. Though the latter phrase has been adopted, the debate about work to be done continues – as it should. But in the course of the first efforts, the Center participants were able to endorse theoretical conception that, in engaging context, elected to privilege the concepts of place and community and lifeworld. Whatever the work might be named, this is its domain (at present).

That story makes the point: This long conversation (about three years of thought and action) is the necessary precondition for elaborating a totally new field of cross-disciplinary inquiry. After three years, the Center was finally poised to apply its commitments to the development of a defined set of questions that represent with full authenticity the inquiry that it sponsors. The Center participants can admit that the research scheme embedded in the Center's original proposal was somewhat naïve and ill-conceived. They can also predict: It will be better later. It should be apparent to readers, however, that these 12 questions break new ground in mathematics education research. This leads to the following recommendation:

> Recommendation 1: Research questions should evolve via a method of successive approximations (rather than be predetermined and fixed).

Technical Processes

Second, the technical process of creating these questions in order to articulate a new field should be of interest to those confronted with a similarly daunting task. Several features of the process are worth mention. The source questions came from a wide variety of experiences and colleagues in several fields (mathematics, mathematics education, rural education, and in technology and science education as well) – professional development leaders, teacher-leaders, administrators, evaluators, professional consultants, and academics. Rural community members are not included in this list, but their concerns are a focus of the resultant agenda and are implicit in the concerns of all involved. (This is one connection that may be "better later.")

The application of a theoretical framework for deciding which questions to select for intensive development seems essential. The strategy of a theoretical framework, moreover, seems wise in an era of diverse research paradigms because it allows the intellectual team to articulate the agreements that enable authentic collaboration. The alternative is to accept a default position of intellectual neutrality – in essence a positivist assessment of "research gaps." That strategy would have resulted in the exclusion of matters of place and community simply because these concepts were so meagerly represented in the research literature on mathematics education prior to 2001.

The execution of the decision-making process by three researchers in the two focal fields also provided a forum for the Center to negotiate its understandings of the framework and of the nuances to be developed in considering and in revising the final list of questions. The researchers' conversation addressed, for instance, such issues as who could speak to what issues, whether or not to weight ratings (two of the researchers were in mathematics education and one in rural education—the decision was not to weight), how to interpret the presenting texts, and whether or not to take an inside-out or an outside-in perspective on a given issue. (This distinction indicated, on one hand, the view of mathematics education from rural place, and, on the other hand, the view of rural place from mathematics education – a distinction that is nicely illustrated by the questions in the culture category.)

In creating the questions and sub-questions, the researchers also considered the twin principles of dispersion and specificity—a feature of the process that applies to the development of the 48 sub-questions. The researchers sought to disperse the sub-questions across a full range of variations: inside-out versus outside-in, within-rural

comparisons versus cross-locale comparisons, qualitative versus quantitative applications, and so forth. They also sought to frame the 12 questions and the 48 sub-questions at comparable levels of specificity in each case. This requirement imposed further, intense discussion on the *stage three* process.

These observations lead to two additional recommendations:

> Recommendation 2: A plan for defining research questions should include drawing upon a wide range of sources, evaluating these against an agreed upon theoretical framework, with a commitment to understanding the important issues in the new field.

> Recommendation 3: Research questions should be broad enough to encompass the field, yet specific enough to define important issues.

Applications

> Recommendation 4: The process described in recommendations 2 and 3 could suitable to discuss with graduate students who need to identify their own research topics.

Mathematics education scholars who work with doctoral students – whether associated with the Center or not – may find this discussion and these particular questions useful. The Center scholars in this position do not assign dissertation questions, however,

but insist (as is common in the field of education) that students define their own intellectual projects, out of which the research questions for their dissertations should naturally emerge.

Many students cannot grasp the process as they enter upon candidacy, for a variety of reasons. The process here – from defining theoretical commitments, to gathering views, to focusing with one's theoretical commitments explicitly made relevant – could help show graduate students the general pacing from an epistemological and ontological stance (a theoretical framework that spells out understandings) to a perspicacious survey of related material (in this case, the 190 questions, but otherwise a program of focused reading) to the definition of general and specific question, and hence to an appropriate selection of methods, a process that is easily stated, but takes considerable time and effort to learn and to follow.

Finally, it should be obvious that this list of questions is invitational. The Center's Research Initiative invites proposals from any researcher on any of these questions. This initial agenda should be worth considering for any researcher exploring the intersection between mathematics and rural education.

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Appendix A
Original 190 Questions with Relevance and Approachability Rankings by each Researcher (R)

		Relevance			Approachability		
#	Question	R1	R2	R3	R1	R2	R3
1	What specific bureaucratic structures need to be in place to support teaching and learning in mathematics in rural schools?	4	2	5	3	3	2
2	Does rurality play a mediating role in hindering bureaucracies?	3	1	1	2	2	3
3	What skills do [rural] administrators and other leaders need to ensure that schools build enabling structures?	3	3	3	2	3	2
4	What political games occur when rural schools implement changes in teaching mathematics?	4	2	5	3	3	3
5	Are fewer or more “political games” played in rural schools?	4	2	2	3	3	3
6	What skills should rural school leaders possess to manage the internal and external politics of rural schools?	3	2	3	2	3	2
7	What are the cultural characteristics of effective rural schools?	3	4	4	3	3	4
8	Are there specific cultural aspects found in rural schools that would enable or hinder efforts to improve mathematics achievement?	4	4	5	3	3	5
9	How can the administrators and leaders influence aspects of local cultures to facilitate mathematics achievement?	3	4	5	2	3	3
10	There is a status system in most contemporary high schools that today values courses and programs leading to college. Consequently, teachers who are the advocates and gatekeepers for these programs are known and respected – even feared – by both other teachers and students. Math teachers are likely key players in these distinctions.	3	2	5	3	2	4
11	To what extent do principal preparation programs serving rural areas address instructional leadership broadly relevant to mathematics education as compared to programs that prepare candidates for suburban settings?	4	4	5	4	3	5
12	To what extent do principal preparation programs and teacher preparation programs located in rural versus suburban areas prepare teachers and principals to work collaboratively together? What recommendations might be drawn for those interested in developing such programs, particularly as regards mathematics education in rural communities?	3	3	5	4	3	5

13	What do rural principals and teachers know and do in establishing mathematically relevant connections with rural communities (i.e., *community connections as a feature of instructional leadership in mathematics education*)?	5	4	5	5	3	5
14	What is required conceptually to lay the groundwork for subsequent development of instructional materials to implement experiential, place-based mathematics pedagogy, such as the Expeditionary Learning Model?	3	5	2	2	3	1
15	What do ... key persons [faculty, doctoral students (especially those who are already faculty at teacher preparation institutions), school administrators and teachers, and citizen leaders from all key sites collaborating in the center] say is needed from research in support of the improvement of mathematics learning and teaching at all levels, Pre-K through graduate?	3	4	2	4	3	5
16	Spread of mathematics reform practices and ideas [in rural places]	4	4	4	1	3	2
17	[Rural] district and school organization and support	4	1	3	1	1	3
18	The equity of local resources devoted to mathematics education (especially with regard to within-rural variability, as Skip Kifer [2001] recommends)	4	2	5	4	2	4
19	Adequacy of resources devoted to mathematics education (for instance, rural funding levels in view of challenges, tax effort, staff turnover, and more)	4	2	4	4	2	4
20	Are there differences in cost-per-graduate of advanced mathematics ... instruction in rural schools versus suburban schools?	5	2	5	4	2	5
21	Are there differences in rural and suburban teachers' and administrators' conceptions of linkages between mathematics... standards, curriculum, and accountability?	5	3	5	5	4	5
22	What is the relationship of mathematics ... policies (standards, content frameworks, assessment) to successful implementation of standards-based mathematics [education]... in the rural circumstance?	4	4	5	2	2	4
23	How can technology be used to develop leaders for ... mathematics education reform in rural school environments?	3	4	4	1	3	2
24	To what extent do leadership expectations, levels of support and encouragement impact teachers' use of innovative strategies in mathematics education .... in rural schools as compared to suburban or urban settings?	3	2	5	3	3	5

25	What experiences best prepare Rural Systemic Initiative teacher partners (lead teachers) to serve in the role of a change agent for the improvement ... mathematics education? (possible case studies).	4	3	4	3	3	4
26	What leadership activities encourage the integration of technology into ... mathematics classrooms in rural schools?	4	4	3	2	3	3
27	What are the factors and experiences which contribute to teachers emerging as leaders for ... mathematics program reform in rural school environments?	4	4	5	4	3	5
28	Are “native” [mathematics] teacher leaders more successful than teacher leaders who move into rural settings?	5	4	4	5	5	4
29	What are the unique situations which promote a “culture of innovation” for mathematics ... programs in rural school settings?	5	4	4	2	3	1
30	What strategies are most effective in developing successful ... mathematics programs in rural school settings? Are these strategies different from those in suburban or urban school environments?	4	5	5	3	4	4
31	How do different applications of mathematics ... standards achieve curricular focus in rural versus suburban schools?	5	4	5	4	4	5
32	Is AYP valid, reliable, and fair? What are the implications of the small size of rural schools and districts for the demonstration of Annual Yearly Progress under NCLB?	5	5	3	5	4	3
33	What combinations of assessments could be used to validate community values for mathematics education, and also serve as evidence of proficiency for math content and performance standards needed for state and federal accountability?	5	2	4	2	2	3
34	How do innovative assessment practices, such as the place-based assessment system recently proposed by the Rural Trust, affect student achievement?	3	4	3	2	3	5
35	Are there assessment instruments and procedures that penalize some students more than others (e.g. according to gender, ethnic/linguistic background etc.)? What are critical dimensions or features of tests or rubrics that facilitate more accurate portrayals of students’ knowledge and skills? What methods of assessment have proved successful by schools serving Native American students? (Strang & von Glatz, 2001).	3	1	4	2	1	4
36	What processes could be used to validate mathematics assessments and tests for Native American students? For example, how might cultural validity (as delineated in Solano-Flores & Nelson-Barber, 2001) be determined?	3	2	4	2	2	3

37	What policy factors influence Native American student achievement on various types of assessments (student transfer policies, attendance policies, test factors, support services, policies for developing curriculum and selecting curriculum materials etc.)? (Strang & von Glatz, 2001)	3	2	4	2	2	3
38	To what extent are Native communities, tribes, villages etc. involved in developing and implementing standards and assessments? What are the differences between assessments and standards systems developed by and with input from Native educators and those developed by non-Natives? (Strang & von Glatz, 2001)	5	2	4	4	2	4
39	How does one determine the authentic assessment instruments and procedures for assessing student learning; do these vary for different content areas of mathematics and for diverse populations?	4	2	4	2	1	2
40	How can student assessments better take into account traits of the learner (values, culturally defined “ways of knowing,” etc.) that might critically interact with and distort or advantage the assessment of student learning?	3	2	4	1	1	2
41	What are the levels of achievement on standardized assessments (e.g., NAEP) for Native American students by grade level or age, state, type of school (public, tribal, BIA), and tribe, and how have those levels changed over the last 10 years? 20 years? (Strang & von Glatz, 2001)	2	2	4	1	3	5
42	How do ... mathematics assessment strategies used by teachers in rural classrooms differ from [those used by] teachers in non-rural settings?	5	4	4	5	4	5
43	[Among instructional practices of confirmed effectiveness,] are some more effective for rural students?	5	4	4	4	2	5
44	What context supports conducting interdisciplinary research [in rural mathematics educaiton]?	3	1	4	3	2	2
45	[To what extent does rural mathematics education research as implemented by the Center have a disciplinary home, and what are the practical and theoretical implications of the plausible answers?]	3	1	2	3	1	2
46	[What constitutes the features of] "best practices" [adapted] to rural areas?	5	5	2	1	5	3
47	What is the efficacy of place-based instruction [in rural schools]?	5	4	5	2	3	5
48	Do the results of the Matthew Project, i.e. that school size mitigates the effects of poverty on student achievement, hold true for rural reservation schools?	3	2	4	3	3	4

49	What impact does the use of place-based education have on student achievement in mathematics in schools with a majority of Native American students?	5	2	5	1	3	4
50	Which types of pedagogy are most successful in raising student achievement for Native American students in poor, rural schools?	3	4	4	1	4	3
51	Are there classrooms in which American Indians/Alaska Natives are receiving standards-based instruction? How does one document implementation of standards and assessment systems? (Strang & von Glatz, 2001)	5	3	3	4	2	5
52	What are the characteristics of schools serving American Indian/Alaska Native students in which standards are implemented appropriately? (Strang & von Glatz, 2001)	5	3	3	4	2	3
53	What are the barriers to implementation of new standards and assessment systems in schools serving Native students? (Strang & von Glatz, 2001)	5	4	5	4	4	2
54	What is the nature and longevity of the implementation of reform efforts in classrooms serving poor communities, particularly in rural and reservation areas? What are the implications of that reform on student achievement in mathematics?	5	5	5	3	5	4
55	In states serving significant numbers of Native American students, are national mathematics education standards (e.g. National Council of Teachers of Mathematics, 2000) supported by state-level content and performance standards, and by the state assessment systems currently in place or under development?	3	2	4	4	3	3
56	What differences exist between national and state level mathematics education standards, and national standards and guidelines for Native American learning (e.g. NWREL, 2002; NIEA, 1999; and AISES, 1994)? Given current researched-based understandings of students' mathematics learning, especially for Native Americans, what are the implications for student learning of the differences between these two categories of standards?	3	2	2	4	2	2
57	What methods do teachers use to successfully enact reform curriculum for students in Native American classrooms? (Boaler, 2002, p. 245)	2	2	4	2	3	3
58	How do limitations in on-line access affect student performance?	2	1	2	2	1	4
59	How does the difficulty of on-line communication affect the types of instructional practices carried out in the classroom?	3	1	1	4	1	3
60	What on-line courses are available to students and what success do students have who are enrolled in them?	4	1	1	4	1	4

61	What are some barriers that limit collaboration between schools and community-based organizations? What are some factors that enhance and strengthen collaboration? (Strang & von Glatz, 2001)	3	2	4	5	3	4
62	To what extent and for what purposes are distance-learning methods used in schools serving Native American students, by grade level, type of school, community characteristics, and tribe? (Strang & von Glatz, 2001)	2	2	3	5	3	4
63	[Rural] small schools	1	1		1	1	
64	The influence of structural features on mathematics education, specifically issues of organizational scale (i.e., the idea of smallness as a quintessentially rural feature)	4	2	5	2	2	5
65	[To what extent is the rural lifeworld represented in mathematics textbooks and instructional materials?]	5	4	5	4	5	5
66	What is the necessary critical mass of personnel required for school change [mathematics curriculum and instruction] in rural environments? Is this different from suburban or urban districts?	3	1	4	4	2	2
67	Is there a difference in the use of digital technology for local sharing ('distance learning in reverse') related to mathematics [instruction] ... among differently situated (ethnicity, region, size, SES, state) rural districts? Is there a difference between rural and suburban districts.	3	1	2	4	1	3
68	Do mathematics ... textbook adoption patterns differ in rural versus suburban schools across critically selected states?	4	4	4	5	4	5
69	What is the accessibility (bandwidth), availability (presence in school), and use of advanced digital technology to teach mathematics ... in rural schools serving impoverished rural communities?	4	3	3	5	4	5
70	How are ... mathematics distance learning opportunities utilized to enhance the learning of students in rural communities?	3	4	3	3	4	5
71	Can the *effective* use of technology for mathematics ... instruction in rural school settings be replicated? What are the indicators of successful "work", e.g., acceleration of learning, additional applications, improve[ment of] skills, etc.?	2	2	5	1	2	4
72	How can the teaching and learning of ... mathematics in rural schools be improved through the effective integration of technology?	2	5	3	1	5	3
73	Are there uses of technology that negatively impact student learning in ... mathematics?	3	4	4	3	3	4
74	What does a highly effective mathematics teacher look like in rural schools?	3	5	5	5	5	5
75	How do rural schools attract and retain teachers who are, or can become, effective teachers?	3	4	5	3	4	3

76	What does effective professional development look like in rural schools?	2	4	4	4	4	5
77	How can rural schools get the professional development they need to ensure that every mathematics teacher has the opportunity to be a highly effective teacher?	2	3	4	2	3	1
78	What will motivate teachers to pursue innovative methods to link their instruction with the local context?	4	2	4	2	3	4
79	How can small rural schools effectively motivate teachers?	2	2	4	2	3	1
80	What factors motivate teachers to stay in rural schools?	2	2	5	4	3	5
81	How is it that cohorts of [rural] teachers could be formed to promote communication among teachers?	3	4	5	3	3	1
82	What leverage can be gained so that at least the first and third principles – that preservice teachers should experience mathematics as a pluralistic subject, and in ways that support the development of process-oriented teaching styles – could be realized in collegiate mathematics courses?	1	4	3	2	2	2
83	What kind of support can be generated for beginning teachers to help ensure their professional survival and enable them to develop critical friends, thus avoiding the lone fighter syndrome?	1	2	1	2	3	1
84	Thick descriptions about preservice teachers' experiences as they move into their initial teaching experience and about experienced teachers who experience the isolation of teaching.	3	2	3	4	3	3
85	What attitudes about using technology in teaching mathematics do teacher participants have before the project begins, and at the completion of the project?	2	1	2	2	1	5
86	What beliefs and values related to teaching and learning mathematics seem to determine the attitudes of the teacher participants about the NCTM Standards, both before and after the project activities?	2	3	2	3	3	5
87	What is the nature of the teacher's self concept related to being a mathematics teacher, and how does it change over the duration of the project efforts?	2	1	1	2	1	4
88	How does the teacher view her/his relationships with other project participants, and how does this view change over the duration of the project?	2	1	2	2	1	3
89	In the case of little change in teaching practices, what emotive factors in the teacher may help to explain the lack of change?	2	1	2	2	1	3
90	[What are the uniquely rural challenges to the improvement of mathematics teaching?]	5	4	5	3	3	3

91	Professional development and support [in rural places]	2	4	3	1	1	1
92	Teacher professional community [in rural places]	2	3	3	1	1	1
93	Internship approaches [for rural teachers]	2	2	2	1	1	1
94	What roles do mathematics teachers play in Appalachian schools and communities?	5	2	5	5	3	5
95	Should professional development for Appalachia teachers differ from professional development designed for all teachers? If so, how?	5	3	3	2	3	3
96	How do career trajectories of advanced mathematics...teachers in rural schools differ from suburban schools; in subgroups of rural schools such as rural schools with high African-American populations versus schools with high Native American populations; or, in schools in agrarian communities versus Appalachian mining communities versus schools in Native American villages?	5	4	4	5	4	5
97	What is the relationship of teacher qualifications (and/or characteristics) to student learning of ... in rural versus suburban (or rural subgroups) schools?	5	4	4	5	2	4
98	Are there characteristics of rural mathematics ... teachers that influence their perceptions of the use of technology, e.g., age, gender, etc.?	4	4	4	4	4	5
99	What are the best uses of virtual learning and technology in preparing and supporting mathematics ... teachers for assignments in rural communities?	2	4	4	2	4	2
100	What type of training is best for improving and enhancing the ... mathematics content knowledge of teachers in rural areas?	2	4	5	2	4	2
101	What are the characteristics of highly competent mathematics... teachers that predict persistence of a teaching career in a rural school setting?	4	5	5	3	5	5
102	How do the resources that *rural* ... mathematics teachers utilize when they need help, differ from [those used by] teachers in *urban or suburban* settings?	5	3	4	5	3	4
103	What policies, state and/or local, encourage mathematics ...teachers to continue their content (mathematics or science) training beyond their initial baccalaureate degree?	2	2	3	3	3	2
104	Do teacher preparation programs exist which are specifically designed to prepare persons for teaching in rural areas? If so, what are the characteristics of [such] programs?	2	4	5	4	3	5
105	How does recruitment of mathematics ... teachers from outside local rural communities compare with recruitment for urban or suburban districts? What strategies are successful in recruiting and retaining rural teachers?	5	4	5	5	3	5

106	What strategies impact the "socialization" of beginning mathematics ... teachers in rural versus suburban districts of various types—affluent, poor, differing ethnic mixes, differing school sizes, etc.	5	4	5	5	4	3
107	What strategies and experiences contribute to the successful preparation of [mathematics] teachers for rural schools?	4	5	5	3	4	4
108	What factors prevent or encourage first year ... mathematics teachers from utilizing their university-learned skills in their classroom practice? (possible case studies)	2	2	3	4	3	5
109	What motivates people to become ... mathematics teachers in rural school districts opposed to what motivates people to become suburban or urban teachers?	5	4	5	5	4	5
110	[To what extent do the concepts of] localism versus cosmopolitanism (Gouldner, 1976) distinguish rural and suburban [high school] mathematics ... teachers?	5	2	4	5	2	3
111	Whose mathematics should be the mathematics of the schools?	2	2	3	3	1	2
112	How is it that we can educate our [rural] teachers to teach and not to indoctrinate?	2	2	2	1	1	2
113	If [rural] students acquire more information, perhaps thus elevating standardized test scores, but at the price of developing an ability to question and to invent, is that improvement?	2	2	2	1	1	1
114	How is it that mathematics gets defined in Appalachian schools?	4	4	5	4	4	4
115	What do teachers believe about mathematics and how do they define their roles as teachers of mathematics?	4	4	2	4	4	4
116	To what extent do these beliefs [teachers' beliefs about the nature of school mathematics] impede or facilitate the use of process-oriented teaching styles?	4	4	2	4	2	5
117	What does it mean to teach mathematics from a pluralistic perspective that embraces human invention?	2	2	2	1	2	2
118	[To what extent is] lack of interest in math [seen by rural teachers as] ... a character flaw of students, rather than an active appraisal of how they [rural students] understand its utility (or meaning)?	4	2	4	4	2	4
119	Locally relevant applications (i.e., of mathematics content and ideas)	5	1	4	1	1	1
120	Intentions of rural teachers and administrators for the mathematics growth of students in their schools (for instance, as represented in school climate, collegiality, relationships among school actors, and behavior reflecting educational purpose)	5	2	5	2	2	5

121	Degree of collective purpose related to or served by mathematics education in rural schools and communities (for instance, student-centered focus, extent of tracking—de jure or de facto, equity of outcomes)	5	2	5	2	2	4
122	[What views of standards-based mathematics reform materials and outlooks do rural teachers hold?]	4	4	5	3	4	5
123	Should mathematics curriculum developed at the national level be adapted for students in Appalachia?	5	4	4	1	4	1
124	What are the correlations of the propaedeutic curriculum (learning more mathematics... principally in order to learn still more mathematics, science and technology) for rural students and communities?	4	3	3	3	3	5
125	How does the taught ... mathematics curriculum differ from the written (or textbook) curriculum in various rurally salient contexts? (rural versus suburban, affluent versus impoverished, white versus black, etc.)?	4	4	4	5	5	5
126	How does the taught curriculum differ from the written (textbook) curriculum for advanced [mathematics] courses?... (rural versus suburban, rural affluent versus rural impoverished, poor white versus poor black versus poor Native American versus poor Hispanic).	4	4	4	5	5	5
127	To what extent does the instantiation of curriculum (from standards to textbooks-in-use, to teacher report, to real-time allocation of instructional time) differ between rural and other settings? (McKnight)	4	3	3	5	2	4
128	Although the metropolitan culture of America is a dominating force, and a force that uses schools to partly teach its ideology, in some more isolated or economically depressed regions of the country, rural high school students continue to define successful living in ways that do not assume obtaining college degrees and leaving home.	4	1	5	1	1	4
129	Educators like to consider the high school as a place for preparing students for real life. The curriculum is where we put much of our effort. We make the mistake, though, of confusing *our* constructions of (curricular) life with the social and personal lives of students. As John Dewey argued, the schools are understood by students not as preparation for (later) life, but as *real* life. Today. Most do not as easily understand it as only a preparatory location as teachers and professors do (Dewey, 1897).	3	1	4	1	1	3
130	[To what extent] is there a culture of failure in rural schools?	2	3	2	2	3	3

131	Does [a culture of failure] exist? What is its nature? Can it be documented? How does it exist in different rural communities? Does it exist in non-rural settings? If so, how do the inherent qualities differ? How might we study this culture?	2	3	2	2	3	3
132	Since the sustainability, growth and improvement of rural schools and communities are inextricably linked, [how can] cooperative efforts ... significantly enhance the simultaneous improvement of both schools and communities?	3	2	2	1	1	2
133	How do teachers from other Native or non-Native cultures serving in a particular Native American currently learn about their students' history, languages, and cultural identity?	4	1	2	4	1	3
134	To what degree do teachers currently integrate this knowledge [of student lifeworlds] in local mathematics programs?	4	4	5	4	2	5
135	What strategies can teachers, schools or communities apply to provide teachers with the cultural knowledge necessary to support their students' mathematics learning?	3	4	5	2	4	3
136	What factors contribute to the effectiveness of programs that show a positive association between academic performance and the presence of Native language and culture?	4	1	3	2	1	4
137	What mentoring and professional development systems could be put in place for pre-service, early career, and experienced teachers in schools serving a majority of Native American students to ensure culturally responsive teaching?	2	1	4	1	1	3
138	What are the characteristics of a high-achieving, culturally diverse mathematics classroom in which family and community values are validated? (Strang & von Glatz, 2001). How is the validation of family and community values measured?	3	3	3	2	1	4
139	What instructional practices have been demonstrated to be effective in helping American Indian and Alaska Native students achieve mathematically in reservation and off-reservation schools?	2	1	4	2	1	3
140	What effect does the use of computers as instructional tools have for Native American students?	3	1	2	3	1	2
141	How can several small districts work together as a system to benefit the needs of all students including those who frequently move among the schools in the system?	2	2	1	2	2	1
142	Do high student mobility rates have implications for achievement and assessment for Native American students attending school on or near Montana's reservations? If so, what can be done? (Strang & von Glatz, 2001)	2	1	4	4	1	4

143	What is the actual student mobility rate between schools? What percentage of the students in a school transfer within a given year? How many times does a student move among schools during a three-year period?	2	1	2	5	1	1
144	What are some cultural barriers that limit collaboration between schools and tribal- and community- based organizations? What are some factors that enhance and strengthen collaboration? (Strang & von Glatz, 2001)	3	1	2	4	1	3
145	Under what circumstances can parental and community involvement have the greatest effect on curriculum and classroom practices resulting in increased student achievement?	2	3	2	2	1	3
146	What type of accounting or tracking system could be used to encourage consistency of policies, curricula and assessment expectations for students attending school within these systems?	2	1	1	2	1	1
147	Is there a shared definition of culture between indigenous communities and the dominant culture? (Strang & von Glatz, 2001)	2	1	2	4	1	3
148	Are there cultural values within American Indian/Alaska Native communities that are lost when children attend school? If so, are there methods of teaching that will help to revitalize certain aspects of that culture? (Strang & von Glatz, 2001)	2	1	5	4	1	3
149	What are localized, culturally specific ways of knowing, teaching and doing that can be translated into educational frameworks or models? (Strang & von Glatz, 2001)	2	1	2	4	1	2
150	How is student achievement in mathematics affected when curriculum and instruction are guided by locally authenticated and aligned content standards, and student performance assessments incorporate high expectations based on tribal history and culture? (Strang & von Glatz, 2001)	2	1	5	3	1	4
151	[Rural] community beliefs about mathematics	5	4	5	1	2	5
152	Local culture of schooling as it effects mathematics education (that is, the embeddedness of a school in its rural community, a condition that is contradictory and not just beneficial; also, in this topic area, competing or dominating, or marginalized conceptions of educational purpose related to mathematics learning)	4	3	5	2	1	5
153	How [did] early Appalachian settlers [use] mathematics or [how do] ... modern-day Appalachian entrepreneurs' use of mathematics?	3	2	5	4	1	5
154	[What are] the varied formal conceptions of mathematics held by Appalachian teachers or the mathematics used by craftsman in Appalachia?	3	4	5	4	2	5

155	[How is mathematics understood differently by varied Appalachian subgoups, for instance] African Americans in Appalachia, male teens in Appalachia, or teachers?	3	2	5	4	2	5
156	[What beliefs do rural teachers hold about their students' potential to learn (or understand) mathematics?]	3	4	5	4	4	5
157	[What are] the salient relationships between mathematical knowledge and rural context?	5	4	5	2	2	4
158	Knowledge of school mathematics serves curiously as a 'gatekeeper' to postsecondary success. Other institutional features of schooling, in like fashion, short-circuit formal educational accomplishment for many rural students. [How do] rural schools... serve or subvert such functions?	4	2	5	3	2	5
159	Mathematics learning should not principally constitute a rural export business. The growth of rural students' mathematical knowledge should, on the whole, benefit rural places and rural communities in better balance with benefits to individuals. [What] place [is] occupied by mathematics knowledge in and (prospectively) *for* rural communities?	5	4	5	2	2	4
160	Extant mathematics curriculum and instruction, whether traditional or constructivist, does not articulate *any* substantive connection with rural context. This oversight is hypothetically harmful to the mathematical learning of rural students. [What is the experience of] "pedagogy of place" for mathematics education in rural schools?	5	5	5	4	4	4
161	What are community perceptions of, beliefs about, and attitudes toward mathematics in Appalachia?	4	4	5	3	5	5
162	How do community members' and parents' constructions of mathematical ... knowledge and use differ in rural versus suburban circumstances?	4	4	5	3	2	5
163	How do parents'/community members in rural areas define the ... mathematics education role of the school as compared to urban or suburban parents'/community members? Does this vary from students' perceptions? Teachers' perceptions? Administrators' perceptions?	4	4	5	3	4	5
164	What do schools and districts need to know about communities in order to make ... mathematics learning relevant?	4	2	5	1	2	2
165	How does community attitude impact ... mathematics instruction and student achievement?	4	2	3	2	1	5
166	What are successful ways schools have involved the community in ... mathematics curriculum development?	4	2	3	3	1	4
167	What mathematical... skills are perceived as needed by people in rural communities?	4	4	5	5	4	5

168	What sort of mathematics knowledge and skills are used in rural communities versus suburban communities?	4	4	5	4	4	3
169	In what ways have schools engaged communities in mathematics ... teaching and learning?	4	3	3	4	2	5
170	What are the implications of the "new economy" in rural areas with respect to mathematics ... learning? In centers versus outlying areas?	4	1	4	2	2	3
171	What are the influences of various forms of social capital on mathematics... learning in outlying rural schools versus schools in rural centers (towns)? Also, in other contrasting populations; e.g., rural versus suburban in selected states.	5	4	5	4	2	5
172	What are the "social class" issues related to teacher delivery and student achievement in mathematics... instruction in rural schools versus schools in suburban or urban settings? In small rural schools versus large rural schools?	4	3	5	3	3	5
173	What is the status of research into mathematics...education in the rural circumstance?	5	5	1	2	3	4
174	How is success in mathematics... defined in rural areas as contrasted to suburban and urban areas? What does community regard as successful? What does the state/nation consider successful? How do parents/community involvement define success? How do students define success?	4	4	5	4	4	5
175	Is out-of-field teaching ... mathematics more prevalent in rural settings than suburban or urban settings? If so, what factors contribute to this situation?	5	4	5	5	4	5
176	Do the SES configurations among students in advanced mathematics ... classes in rural, small-town or suburban schools differ?	5	2	3	5	2	5
177	How can teachers in rural schools make mathematics and/or science relevant to real life contexts?	5	5	5	1	3	3
178	Is "informal education" in science and/or mathematics more influential in a rural setting than suburban or urban setting?	4	2	4	3	2	3
179	Although many teachers and state education officials will explain lack of academic achievement in some rural schools as indicative of poor student attitudes or abilities, some, even many, so-called "low achievers" actively choose what they will study and how much they will study *because* their future goals may not include academic higher education (see Conjectures #1 & #2).	3	2	2	2	2	2

180	Many fully able high school students faced with academic choices in high school will actively choose vocational courses and programs over academic ones *because of* their future aspirations and plans.	3	2	4	1	2	3
181	Since there is great talk about wanting to make rural high schools as "successful" as suburban ones these days, those who wish to create interest and desire among the larger student body will have to acknowledge that *not* choosing higher academic school offerings is rational for some students. Any high school that truly wants to induce all students to attempt and complete higher academic coursework will have to create ways of making such choices possible and desirable for students, and will have to reduce the status differentials between vocational, general and college track students and teachers.	4	2	3	1	2	1
182	How does the student's "sense of self" (reflected in his/her sense of competence and sense of status) relate to motivation, academic achievement and retention in school? (Demmert, 2001)	2	4	1	5	2	4
183	[What sorts of variability in student achievement characterizes rural settings; e.g., how do achievement levels and growth vary by SES, prior achievement, language background, ethnicity, degree of rurality, region (e.g., Appalachian vs. non-Appalachian)?]	4	3	3	5	2	4
184	Where do Appalachian students capable in mathematics go?	5	4	5	4	3	5
185	Is there a difference in the delivery of advanced mathematics ... courses or content in rural high schools in largely black schools in the rural 'black belt' versus largely white schools in the rural 'black belt'? This issue could be framed in SES terms, of course, and still confined to the "black belt" so that race emerges as covariant in ancillary analyses.	5	1	5	5	1	5
186	What activities, conducted by colleges, help rural students majoring in mathematics ... transition successfully to higher education?	3	3	5	3	1	5
187	What factors encourage females to pursue degrees in mathematics... in higher education? Is there a difference in rural students compared to non-rural?	4	4	4	4	4	5
188	Are there differences ... or inequities in student opportunities to utilize instructional technology [in mathematics offerings] in rural schools due to gender or socio-economic status?	4	4	4	4	3	4
189	How do "traditional" rural gender roles impact mathematics... achievement in rural school settings? Do "traditional" rural gender roles impact course-taking in ... mathematics?	5	2	4	4	2	4

190	What instructional strategies result in higher student achievement in mathematics and/or science in rural schools? Are similar results obtained in urban and/or suburban schools?	5	2	4	2	2	5

Appendix B

Top 25 Questions sorted by Average Standardized Relevance

1. What is the nature and longevity of the implementation of reform efforts in classrooms serving poor communities, particularly in rural and reservation areas? What are the implications of that reform on student achievement in mathematics?

2. Extant mathematics curriculum and instruction, whether traditional or constructivist, does not articulate *any* substantive connection with rural context. This oversight is hypothetically harmful to the mathematical learning of rural students. What is the experience of "pedagogy of place" for mathematics education in rural schools?

3. How can teachers in rural schools make mathematics and/or science relevant to real life contexts?

4. What do rural principals and teachers know and do in establishing mathematically relevant connections with rural communities (i.e., community connections as a feature of instructional leadership in mathematics education)?

5. How do different applications of mathematics standards achieve curricular focus in rural versus suburban schools?

6. What is the efficacy of place-based instruction in rural schools?

7. What are the barriers to implementation of new standards and assessment systems in schools serving Native students?

8. To what extent is the rural lifeworld represented in mathematics textbooks and instructional materials?

9. What are the uniquely rural challenges to the improvement of mathematics teaching?

10. How does recruitment of mathematics teachers from outside local rural communities compare with recruitment for urban or suburban districts? What strategies are successful in recruiting and retaining rural teachers?

11. What strategies impact the "socialization" of beginning mathematics teachers in rural versus suburban districts of various types—affluent, poor, differing ethnic mixes, differing school sizes, etc.

12. What motivates people to become mathematics teachers in rural school districts opposed to what motivates people to become suburban or urban teachers?

13. What are rural community beliefs about mathematics?

14. What are the salient relationships between mathematical knowledge and rural context?

15. Mathematics learning should not principally constitute a rural export business. The growth of rural students' mathematical knowledge should, on the whole, benefit rural places and rural communities in better balance with benefits to individuals. What place is occupied by mathematics knowledge in and (prospectively) for rural communities?

16. What are the influences of various forms of social capital on mathematics learning in outlying rural schools versus schools in rural centers (towns)? Also, in other contrasting populations; e.g., rural versus suburban in selected states.

17. Is out-of-field teaching mathematics more prevalent in rural settings than suburban or urban settings? If so, what factors contribute to this situation?

18. Where do Appalachian students capable in mathematics go?

19. What strategies are most effective in developing successful mathematics programs in rural school settings? Are these strategies different from those in suburban or urban school environments?

20. What are the characteristics of highly competent mathematics teachers that predict persistence of a teaching career in a rural school setting?

21. What strategies and experiences contribute to the successful preparation of mathematics teachers for rural schools?

22. Are there differences in rural and suburban teachers' and administrators' conceptions of linkages between mathematics standards, curriculum, and accountability?

23. Are "native" mathematics teacher leaders more successful than teacher leaders who move into rural settings?

24. What are the unique situations which promote a "culture of innovation" for mathematics programs in rural school settings?

25. How do mathematics assessment strategies used by teachers in rural classrooms differ from those used by teachers in non-rural settings?