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The Social Construction of Rural Mathematics

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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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The Social Construction of Rural Mathematics

Final Report to ACCLAIM

by
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Project Introduction

An announced aim of the research group for the Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics (ACCLAIM) is to gather landscape information related to mathematics teaching and learning in rural Appalachian high schools. Does context (i.e., rural and Appalachian) have meaningful impacts upon the math instruction and outcomes in rural high schools? This small research project aimed to give some preliminary data on these topics. The task as defined was an exploratory one, and its focus was primarily interpretive and not statistical. Entitled the "Social Reconstruction of Rural Mathematics," the work that follows was primarily interested in more subjective variables: perceptions, understandings and interpretations of the meaning and use of mathematics among teachers, students and administrators in two participating rural Kentucky high schools.

Some Methodological Considerations

As commissioned, the study focuses upon a "convenience" sample of two Kentucky high schools and their math programs, along with teachers and students who volunteered to be observed in classes and interviewed in the schools. There was also an attempt to collect some basic documents related to school contexts, educational achievement and schooling objectives during the past several years (2000-2003), and to download relevant information from school district websites. This project's primary

rationale and methodology, however, were qualitative. Such work is typically concerned with discovering and uncovering persistent themes and orientations within self-contained "cultural scenes," like American high schools (Spradley, 1979). The role of the researcher is not to test a hypothesis, but rather to describe and report upon lived experiences as witnessed and understood by those within the cultural or sub-cultural milieu (Bogdan and Biklen, 1998).

No research or researcher is in fact information or theory-free during data entry, observation, or recording. Rather, the qualitative researcher is required to recognize, consider, and declare sources affecting the research focus. In this work, the focus derives very loosely from previous interests and research in rural high schools in Appalachia, a topic this researcher has previously pursued (e.g., DeYoung, 1991; 1995). Choices are also made within contextual studies of schooling, as disciplinary bias is a constant shaper of question construction and interpretation. There are in fact many literatures that purport to assess the life and educational experiences of young rural American adults in this region. Rural sociology, Appalachian studies (in this case), and adolescent psychology, for example, all proclaim high school students in rural places within their spheres of study and expertise. The education literature as well contains many disparate voices and approaches to the study of academic achievement: there are curriculum specialties and motivation theorists of many sorts who concern themselves with matters close to this subject, but who frame and define the research questions differently than is done here.

The literatures that informed this project are primarily contextual and social scientific. The work is partly situated within the tradition of several classic sociological studies of the rural American high school, and incorporates some writings and

perspectives related to the particular regional and state (Kentucky) educational reform dynamics during this decade. The academic frameworks of the work are anthropological and sociological. To this extent, I treat the social relations of the high school as most critical, and the continuing academic trends and debates found at the sites as having an impact on the social construction of meaning there.

Historical Precedents

Sociologically speaking, American high schools historically pursued two functions during the early and mid twentieth century: socializing adolescents into mainstream American life (i.e., giving them a common pre-adult experience and often enabling students to emigrate to the city), and simultaneously stratifying them into different futures based upon perceived differences in ability and interest (Brint, 1998; Perkinson, 1995). The stratification dimension of the high school traditionally pitted advocates who understood the role of high school to prepare future college goers against those who believed that high schools should serve primarily as terminal (vocational) institutions dedicated to preparing future workers for direct entry into local labor markets (Kliebard, 1986; Trow, 1959).

At the organizational level—the level of lived experience for purposes of this report—there has invariably been a struggle within schools for the moral high-ground related to the curriculum: academic versus commercial/vocational/technical (Collins, 1979; Letrende et.al. 2003). School success and school purpose have typically been couched in terms of winners and losers: students who should be here because they "work hard" and want to, versus those who are "unable" or "lack motivation." In sociological

terms, the former students fit the school's norms and expectations; the latter do not. This observation, of course, raises issues of what are the norms or the desirable aims of schooling, and who gets to define them. The answers have changed over time, as many historical accounts of the transformation rural elementary and high schools in an urbanizing American nation so eloquently narrate (e.g., Fuller, 1982; Hartford, 1977; Tyack, 1977).

For example, a primary curricular struggle during the twentieth century took place between those who championed public high schools as sites for academic instruction, preparing students for college or at least giving them broad instruction in the humanities, versus those who championed a practical or vocational focus. This contest has been particularly characteristic of rural high schools, where teachers may have directed their students either toward academic courses (e.g., physics, algebra, English literature) or toward vocational specializations (e.g., agriculture, welding, carpentry) consistent with their often stated preferences. Unfortunately for many students (both rural and urban), the debate over these contending normative expectations has historically been cloaked in arguments over "student ability" or attributed quality.

In many rural places, teachers who championed the high school as the site for college preparation fought with more locally focused teachers and administrators who believed the school should create more talented farmers and workers for the local arena (e.g., Fuller, 1982; DeYoung, 1995; Peshkin, 1978). The classic sociological work on small-town America and its high school by Hollingshead articulated this tension well at mid-20th century (1949). In his look at internal dynamics of the school related to the

curriculum, he found tensions that sound similar to some of today's, although who holds the moral high ground seems to have changed since then:

> Because the academic teachers believe that college preparatory students have more ability, are more interested, and do better work than those in the general course, they prefer to teach the former group. Although these contentions may be true, more probably teachers of the college preparatory group satisfy their desire to see the students reflect the academic values they hold…. The vocational teachers differ from the academic teachers in their estimates of student ability, as they do in most things relative to the school; they believe that students specializing in their courses are as bright as the rest of the lot. These divergent beliefs between the two groups are in part a defense of their own interests and in part a result of the thinly veiled animosity that prevails between the academic and the vocational teachers. … The cleavage between the academic and non-academic interests enters into every aspect of school life--curriculum, grades, student government, athletics, and the cliques in which one participates (pp. 171-172).

John Dewey understood this issue well, but had hoped the curricular chasm could be bridged (1899). He argued that such curricular tensions reflected both individual interests as well as changing demographic and occupational issues. The task was not to allow either "side" (academics or vocational) to "win," but rather to create a school where these competing norms could be reconciled and put to mutually beneficial use. He claimed that high schools contained both those interested in using the high school for

college entry (the “knowledge accumulators”) *and* the “doers and makers,” those students who had more immediate and practical interests in life but yet needed formal education. In his view, neither group nor their instructors could claim the moral high ground related to the curriculum:

> Our school methods, and to a very considerable extent our curriculum, are inherited from the period when learning and command of certain symbols, affording as they did the only access to learning, were all-important. The ideas of this period are still largely in control, even where the outward methods and studies have been changed. It is an education dominated almost entirely by the medieval conception of learning. It is something which appeals for the most part simply to the intellectual aspect of our natures, our desire to learn, to accumulate information, and to get control of the symbols of learning; not to our impulses and tendencies to make, to do, to create, to produce, whether in the form of utility or of art. While training for the procession of learning is regarded as the type of culture, as a liberal education, that of a mechanic, a musician, a lawyer, a doctor, a farmer, a merchant, or a railroad manager is regarded as purely technical and professional. The result is that which we see about us everywhere--the division into “cultured” people and “workers,” the separation of theory and practice. … If we were to conceive our educational end and aim in a less exclusive way, if we were to introduce into educational processes the activities which appeal to those whose dominant interest is to do and to

> make, we should find the hold of the school upon its members to be more vital, more prolonged, containing more of culture (26-29).

More Recent Rural School/Community Scholarship

Social scientific/interpretive studies of rural American education (i.e., where rurality is a focus of the research rather than one of several residual categories) are extremely rare. Alan Peshkin's 1978 study of "Mansfield" found similar dynamics as reported earlier: that many rural high schools yet contained advocates for both the pre-college academic curriculum, as well as for a curriculum for students who did not plan to travel away to school or to work. The Illinois school and community he studied, however, seemed to have remained somewhat blessed. It had apparently not experienced much of the rural economic decline seen even then in many states, and certainly in most rural places since the 1960s. Most of the students at Mansfield High, as well as their parents, were thinking of the high school as the last educational institution their children would inhabit. Their interests were for the more practical, as a whole.

Meanwhile, Martin Trow had already argued that the national trend would be different and affect all American high schools. Even "practical" occupations in the future, he claimed in 1959, would require post-secondary education, and the end of the 20th century would see a new struggle over how to transform our high schools from "mass terminal" to "mass-preparatory." The division of labor in society, in effect, was undermining the utility of the American high school to be mass terminal by this era. Most work in the future would require some post-secondary schooling.

At the same time, , national schooling critics like Bester (1953) railed against "life adjustment" and vocationalism in American schools during the cold war era. They

rhetorically sounded the attack on the high school as mass-terminal. Targeting rural education more pointedly, James Conant argued that small high schools—far more often to be found in rural America—were not sufficient to provide the academic rigor and opportunities to prepare students from small communities for college and more academic futures (1959). Such widely read works seem to have accelerated a rural education trend already underway : high school consolidations into larger school units.

School reformers of the 1950s appear to have had major success: by the mid 1960s, Henry Perkinson could argue, most American high schools had already abandoned a local focus on community improvement and "life adjustment" via the school, and instead had turned their energies to enabling high school students to escape the local in favor of careers elsewhere (1995). The route out of rural communities at the time seemed to be via academic programs and college attendance. These efforts, it should be noted, were due in part to early efforts of the same National Science Foundation that supports the initiatives of the present work.

For most of American students, even rural students, the social transition of the US has increasingly involved the exhortation that "school is a place to use for a good job and to move." It seems plausible, however, that some rural students yet consider other options for schooling that do not involve college and leaving, as in generations past. Or if it does involve college and leaving, it might be community/technical/vocational college and regional "leaving" for jobs within commuting distance from home, where they remain anchored to extended families and religious communities (Bickel, 1989; Herzog and Pittman, 1995; DeYoung, 1995).

At the state level, rural education policy advocates also have voiced concerns about teacher recruitment and retention, teacher "quality," and professional development issues (Hare, 1991; Horn, 1985). School consolidation—perhaps the primary community concern related to education in rural places—has also been tied to academic quality or academic comprehensiveness concerns, as noted above. Smaller high schools, it has often been claimed, cannot provide concentrated specializations in academic subjects (like advanced math) since there are not enough students to justify courses for specialized instruction (DeYoung and Howley, 1990). Optimal rural high school size and organization has been a major concern of state education departments now for decades (Monk, 1991).

To sum up, the role of academics in rural American high schools is posited by many social scientists as not only tied up with the "quality" of academic instruction, but also with demographics and the structure of local economies. Local economies and local demographics also are clearly understood to affect school organizational and curricular issues. This study, then, is keenly interested in the interplay of increasing emphasis on academic instruction, primarily mathematics, within rural and Appalachian high schools of the US. This research looks at two rural high schools within the Appalachian Regional Commission's definition of Appalachia. Importantly, this "sample" lies within the state of Kentucky, which is a critical variable. NCLB not withstanding, state education policy remains the driving force behind any efforts at school quality in the 21st century. Kentucky, as it turns out, has experienced significant school reform over the past decade with regard to school quality, and the state accountability scheme will emerge in pages below as a key theme in this report.

Ethnographic Methods

Constructivist or interactionist views on schooling dynamics attribute primary agency to students and teachers, paying less attention to psychological dispositions or structuralist/organizational variables (Woods, 1983; Atkinson, 1990). This theoretical/ interpretive perspective is central to aims of this research, where the intent is to understand the intersections of demography, economy, curricula and instructional strategies at the level of lived experience. As Geertz explains:

> Interpretive explanation—and it is a form of explanation, not just exalted glossography—trains its attention on what institutions, actions, images, utterances, events, customs, all the usual objects of social-scientific interest, mean to those whose institutions, actions, images, utterances, events, customs, and so on they are. As a result, it issues not in laws like Boyle's, or forces like Volta's, or mechanisms like Darwin's, but in constructions like Burckhardt's, Weber's, or Freud's: systematic unpackings of the conceptual world in which *condottiere,* Calvinists or paranoids live (1983: 22).

We are here interested in explaining how teachers and students "construct" and interpret curricular meanings and actions they experience or represent at the school building level. Consider Peter Wood's explanation of how the school might be understood or interpreted by individuals in his introduction to the sociology of education. This citation can quite easily be fashioned to investigate how rural high school students of yesterday and maybe today interpret the school and its curricula:

> At the heart of symbolic interactionism is the notion of people as constructors of their own actions and meanings. People live in a physical world, but the objects in that world have a "meaning" for them. They are not always the same objects for the same people, nor are situations interpreted in the same way. To some, school is a joyful and liberating arena, to others it may appear dull and restrictive, and be compared to prison or an army barracks. To the same person, a piece of chalk might be a writing implement on one occasion, a missile on another. In other words they are symbols—they indicate to a person certain meanings which are dependent on them for their construction (1983, p.1).

A Note On Appalachia

There is in fact a long tradition of work that proceeds from an "Appalachian otherness" tradition, where the upland south and east is suggested to outside the norm of American culture. Much of this work—which originated early in the 20th century, but accelerated during the War on Poverty—suggests that Appalachia is a backward place occupied by backward people requiring special programs and dollars in order for residents there to catch up to the national mainstream (see Whisnant, 1980; Eller, 1982). This research project does not assume this cultural deficit paradigm. Rather, the schools and communities of this research are considered to be among the larger rural community and school populations of the US, albeit with some special characteristics.

Gjelten suggested decades ago that there are five rural community types in the US whose demographic and economic characteristics distinguish them from each other (1978). Appalachian communities typically fall within each type. There are growing rural areas contiguous to metro places, as well as those closely connected by highway and

rail systems to metro hubs. Such community types usually have infrastructures and information sources approximating metropolitan America. There are also rural agricultural counties and communities with still-viable farming or extractive economies. More disadvantaged in many ways are those places in persistent economic decline due to non-competitive rural economies, and those that never had strong economic bases due to their geographic isolation. All such places, though, have had schools and high schools since the early twentieth century, but their pedagogical circumstances have often differed dramatically during this period.

Unfortunately, many rural Appalachia communities have historically fallen into one or both of the latter two of Gjelten's categories since the 1950s: places with declining economies, or else remote areas of the country (far removed from cities, highways, or other transportation centers).

Appalachia is typically understood as the large a mountainous region of the eastern US that once depended upon subsistence agriculture and later on extractive industries (timber, coal and gas). Portions of 13 different states fall within this region. With the decline of agriculture and extraction in Appalachia, many rural communities have struggled financially over the years. Meanwhile, of course, expectations and demands for schooling have increased.

Schools In The Region

The schools visited for this study lie within the Appalachian Regional Commission's designated area, and also have been identified by the National Science Foundation (NSF) as among the many in the region in need of special attention in math

and science. In fact, the two schools researched here volunteered to be part of this project partly due to their involvement in the Appalachian Rural Systemic Initiative (ARSI), even though funding for this particular research came via resources of the Appalachian Collaborative Consortium for Learning and Achievement in Mathematics (ACCLAIM).

One incidental observation in this study was that most interviewed school teachers in Each of the two high schools about to be discussed understood that the NSF is actively working to improve mathematics teaching in their schools, but most were a bit unsure how and under which NSF category the school improvement projects they were part of were being operated. This may likely become all the more confusing as even more funding for many regional schools, including the two under review here, may become available via the NSF's newest $22 million blockbuster, the Appalachian Mathematics and Science Partnership (AMSP). In the end, it was probably unimportant that the teachers did not know exactly where and how the money targeted in each of the following schools was earmarked. All teachers in this work did know they were receiving special attention, and all of them reported enjoying the experience.

The Schools And Their Communities: Gaining Entree

Schools were recruited for this study at a meeting of "Teacher Partners" for the ARSI in the Spring of 2002. I gave a short presentation of aims of the research – to better understand how mathematics was viewed by students in participating ARSI schools in hopes that such information might better inform practitioners of the ACCLAIM project. One of the half-dozen assembled high school Teacher Partners volunteered her school; another of the perhaps equal number of middle school teachers suggested her district

might find this ok, but I would have to contact the high school formally. Principals at both high schools were subsequently contacted, and both agreed to my future visits and interviews to investigate the "social construction" of mathematics. Importantly, both schools were already involved and active in the ARSI work, and seemed eager to cooperate in this undertaking as a potential mechanism to further the math improvement work their teachers were already doing. As it later proved to be, both schools had long histories of active and strong math teachers and departments in their schools, thus suggesting they may be atypical of the larger rural high school population of the US. We cannot know from these two schools alone.

A partial picture of River County High School (RCHS)[1] can be gleaned from several county web sites in 2003. The high school is located in northeastern Kentucky, near the Ohio River. RCHS serves grades 9-12, with a total 2002 enrollment of slightly more than 600 students and a teaching staff of 36. RCHS claims, understandably, to have "an excellent academic program" as well as "a wide variety of extra-curricular activities." During the 1996-97 year, the school proudly announced, it became a Kentucky TeleLinking Network (technology) site. RCHS also describes itself as "neighbor" to both the local Career and Technical Center and the county middle school. Like many, if not most, rural counties in this part of Kentucky, the county has only one high school and one middle school. There are also four elementary schools. The county also went through a dramatic high school consolidation in the late 1980s that reportedly let to early retirement of the then-superintendent. He is now a part time administrator in the high school

[1] The names "River County High School," "Lakeway County High School," and other specific place names throughout this paper have been fictionalized to preserve the confidentiality of the informants.

Although the county lies along the Ohio River, there is currently little local commercial activity on the river that positively affects community life in River County. There are also no bridges across the river directly into Ohio from the county seat, which contains numerous empty storefronts and vacant lots. River County remains one of the poorest in the state, and had about double the state unemployment average for 2002. (The official state average was 5.6%.) Earlier this decade a new highway was constructed, connecting a rapidly growing town on the interstate to the east with the older, but revitalizing, river town of Maysville to the west. Local accounts, though, suggest that this highway has helped many more people leave the county than to come into it, bringing new jobs or ideas.

Lakeway County High School (LCHS) is also in ARC defined Appalachia, but this county and its county seat are much more centrally located to interstate travel from north to south and from east to west. Lakeway County is in a better economic and demographic situation than River County. It has almost twice as many residents (16,629 in 2001); about the state median household income ($23,475 in 1999); only 5.8% of the workforce was unemployed in 2002. Interstate 75 runs from Cincinnati to the north, down to Lexington, then passing the county seat of Lakeway County on the way to Knoxville and Atlanta to the south. Another primary highway connecting I-75 to Lake Cumberland in south-central Kentucky runs through the center of the county. Compared to River County, there are a plethora of fast food and convenience stores at the intersection of these highways. Many employ high school students part time; they also provide meeting places for young people after school. Tourists passing through are easily seen, particularly the “Ohio Navy,” as out-of-staters towing boats behind SUVs are

termed. County officials are also quite proud of the fact that virtually every type of post-secondary educational opportunity is in or nearby their county.

There are also seven schools in Lakeway County: three elementaries, a county middle school, a small alternative school and the county high school. As well, there is a vocational-technical center in the county, but it lies down the hill near the middle school rather than contiguous to the high school. The recently built high school has ample surrounding space for new facilities, though, and the long-term plan of the school board has been to enhance and move the vocational/technical center up closer to high school in coming years. Unlike the River County high school—which is certainly functional and which has been nicely expanded and upgraded over the past several decades—the Lakeway County high school is a grand, new mid-1990s architectural specimen. Its entry way is all glass; to the right, an ascending stairway proudly displays half-a-dozen recent state awards in academics and sports activities, while to the left, an expansive administrative center and lobby welcome visitors. There are also several other new school buildings in the county.

From the Lakeway County High School (LCHS) web site, the school appears similar in many ways to the high school of River County (RCHS). The Lakeway school serves a somewhat larger student population (about 800 students), and touts a strong academic emphasis "reflected in the fact that LCHS has been a school in rewards in three state bienniums." (The state accountability system will be discussed more fully later in this paper.)

> In addition to the core curriculum, students may take vocational classes at the nearby Kentucky Tech Center and on-site dual credit college classes through Somerset Community College. The Tech Prep program aligns curriculum and develops articulation agreements with various colleges and technical schools to help students complete career majors. Seniors may participate in work-based learning in local banks, businesses, health care facilities and at (the local tourist music attraction). Special attention is given to transitions, from middle to high school and from high school to post-secondary education, the world of work, or the military. Various clubs and organizations enhance learning and promote academics, community service and leadership. A varied athletic program offers football, basketball, softball, baseball, volleyball, cross country, and track to nurture the "well-rounded" student

Academic Themes at the Schools

Cultural anthropologist James Spradley (1972) argues that focusing upon cultural *scenes* and embedded *themes* are important strategies for studying subcultures in organized social institutions, like the school. Schools provide many sites within and without their buildings for the construction and negotiation of daily life, as Woods earlier described. Cultural scenes are those socially created places of human interaction where much of culture is transmitted and meaning is created and shared among participants.

> Cultural scenes are closely linked to recurrent social situations (like classrooms and the cafeteria). The latter are settings for action, made up of behavior and

> artifacts that can be observed by the outsider; the former are the definitions of these situations held by the insider. … If each individual's culture is an immensely complex cognitive map, we may think of each cultural scene as a region or area of that map (Spradley, 1972: 24 & 27).

The aims of this research are obviously concerned with recurrent social situations like classrooms and teacher spaces where the focus is mathematics. How mathematics is understood in the social situations and the related cultural scenes where math and those who teach and study it are to be found is central.

Describing and interpreting cultural *themes* to be found in and around those places where high school mathematics is taught and "constructed" is a primary methodology and focus of this work. Spradley credits Morris Opler (1945) with first defining and using theme analysis to understand cultures and sub-cultures. A cultural theme is a:

> postulate or position, declared or implied, and usually controlling behavior or stimulating activity, which is tacitly approved or openly promoted … . Cultural themes are elements in the cognitive maps which make up a culture. Themes are larger units of thought. They consist of a number of symbols linked into meaningful relationships. A cognitive principle will usually take the form of an assertion such as "men are superior to women," or "you cannot beat a drunk charge." A cognitive principal is something that people believe, accept as true and valid; it is a common assumption about the nature of their experience (Spradley, 1979: 185 and 186).

More complete educational ethnographies typically include long periods of such strategies as observation, participant observation, behavior mapping, life histories, artifact collection or documentation, etc. (Merriam, 1998). Most of these qualitative techniques either explicitly or implicitly use "what people say" as part of the larger ethnographic project. In this limited research project, the fieldwork strategy has primarily had to focus on "what people say" as a primary tool for investigation. The primary strategy for soliciting and describing cultural themes in this study has been the ethnographic interview, although other forms of public speech related to academics in each of the two high schools studied is included. These situations are specified later in the text.

According to Spradley, "every ethnographer makes use of what people say in seeking to describe their culture. Both tacit and explicit culture are revealed through speech, both in casual comments and in lengthy interviews. … and the ethnographic interview is one strategy for getting people to talk about what they know (1979: 9)—specifically, how and where they "construct" the meaning of mathematics in the "recurrent social situations" and cultural scenes they inhabit.

Participants In The Research

This study was limited to several weeks of actual data collection within each of the two schools of the project. Contacts with each school and its Principal were made in the Fall of 2002, but data collection did not formally begin until January, 2003. Data were for the most part collected serially. Normally, visits and observations were made and interviews arranged at RCHS one or two days a week in February, March, and April;

subsequently, visits, observations and interviews were conducted at LCHS in April through May.

Visits included participation in math department faculty meetings at both schools, the collection of school and state academic documents at each site, observation of school-wide assemblies and activities on days visited, etc. I also collected information related to internal or statewide academic awards provided to visitors, parents, and citizens that was available either in the outer lobby of the central office or at libraries at each school. Also, each school district has a modern web site with links to district and school the annual updated and state mandated Consolidated (improvement) Plan.

Primary data collection for this study involved ethnographic interviews and field notes based upon school observations and the interviews. The intent of this research was not only to describe situations in each school, but also to attempt to understand the "social construction" of mathematics, which is primarily subjective. Understanding how affected and involved participants in the school constructed meaning around math and related academic concerns in their institutions was central. I therefore interviewed administrative staff at each school, including each principal and at least one academic guidance counselor, and at least one other staff member with primary responsibilities involving students and their programs. This also involved interviewing the principal and guidance counselor at the Technical and Vocational Center, because it was also attached to but not under the administrative control of the high school.

Primary data/interview sources for this work were the mathematics teachers at each high school. At one school, all were interviewed. At the other, four of six, plus the math dedicated ARSI "Teacher Partner" were interviewed. Various types of student

groups—identified as both high-achieving and lesser-achieving by school personnel—also were interviewed. Parents, another group that would ordinarily be involved in "constructing" math, were not interviewed due to time constraints of the research. At one school, however, I did attend and listen to academic concerns of the Site Based Decision Making Council, which theoretically represented parent academic concerns at that school. A total of approximately 100 in-school hours went into this project, about twice as many as were specified in the original project contract. Slightly more of these hours were spent in RCHS, because documents containing comparable information for LCHS already were available. The data is presented in case study format, a strategy well rehearsed in qualitative research (Merriam, 1998).

In the course of visiting, observing, and interviewing, several individuals became for me "key informants": staff and student members in the schools who seemed to understand my interests and who spent extra time explaining contexts and situations to me. Most of them have some voice in the pages ahead, either directly or indirectly. Three of these individuals also read and responded to the first compete draft of this study. Their concerns and suggestions were for the most part incorporated in the revised report you read now.

The Questions

This work was primarily focused upon collecting and analyzing interview data related to how students, teachers and administrators thought about mathematics instruction and the importance in general of math in two Kentucky high schools. The interview format was comparatively informal (see Bogdan and Biklen, 1998).

Descriptive questions were typically asked in each interview attempted in this study: most of the individuals and groups queried were asked to describe the formal math curriculum and sequence in the school, who taught the courses, and what sorts of general issues were involved in classes taught.

A second set of questions involved perceptions of quality of teachers and teaching in each school and school improvement efforts focusing on curriculum and academics to be found at each institution. A subset of these questions focused on "barriers" to instruction, including problems arising from descriptive or relationship issues in math instruction in school. Additional questions related internal math teaching to external constraints or opportunities for math teaching and curricular improvement.

A third set of questions focused on some of the rural context issues discussed earlier. These questions sought to illuminate academic "stratification" in the high school, particularly as it related to mathematics. Were some kids better or worse at math; and was this assessment related to external demands for math or to internal student and faculty subcultures related to academics, as was suggested in the block quotes above from the literature?

Questions asked changed somewhat during the six months of fieldwork. In each of the schools, my presence and interests became known during the work. Many "subjects" of the research learned quickly that I was a professor from the state research university, and by later stages of the work some of the entry descriptive questions I began with had already been anticipated or seemed mostly answered. In several cases, teachers in one or another of the schools had assumed that I was one of them or had already learned basic things, and they wanted to have serious conversations with me. Key

informants were identified in this process, and in some of the following passages I quote at length from those who seemed to both understand my intent and who were happy to tell me their stories.

As an illustration of an entry question set, consider the interview schedule I composed for my first group interview with the "calculus group," identified by the Assistant Principal of RCHS and invited to speak with me as a group. First I asked them to describe the mathematics graduation requirements at their school; and the possible options a student could choose to meet those requirements. Then I asked who had input into the choices students made about what to study in school, and how students were "assigned" to particular classes. Subsequent questions became more subjective. I asked the ten students who came to the session—made available, it appears, because they were advanced students and had the time to give, as opposed to other students who ostensibly needed more attention during their brief homeroom period—to describe the perceptions that their friends and classmates voiced regarding course difficulty. I also asked them what percentages of students, in their opinion, might be considered to be in more demanding classes, versus those in less demanding classes. I also asked them to tell me briefly about the "non-academic" math classes, for example, in the technical/vocational programs of their school. I obviously heard a lot of opinions on such matters in the two sessions I had with this group.

I then asked these students to talk about their teachers. Did they have opinions about ease or difficulty of different math classes? Did teachers tend to reveal to these "better" students their own frustrations regarding students who had a harder time mastering content? And were those slower students assumed to be less able,

unmotivated, or what? I also asked directly about motivation. Did their fellow students who seemed to have greater difficulty in math have these difficulties because they were less able, or because they were known to not work hard at their studies? Were some courses considered "hard" by all students; by some students? Which courses; which students?

Following upon these, I asked students to report on teacher reputations among the students. Were any clearly "better" than others? Which ones? Why? What were the characteristics of teachers thought to be better than others? And, which course, if any, were thought by the students to be most challenging for teachers? Did teachers report difficulties in teaching any courses? Why?

Principals and teachers, too, were asked variations on each of the questions above, as well as about other school matters that I judged students might have less information or concerns about. In general, these questions focused on teacher tenure, how teachers were reviewed and supported or sanctioned, how the math teachers in the building(s) compared with teachers in other departments, etc. I also asked administrators questions about student groups and academics, and about if and how officials and parents external to the school expressed interest or concern with mathematics in the school or regarding their teachers. Interviews in the school were for the most part set around class schedules. Block Scheduling was practiced in both sites, making 90-minute interviews possible. In some cases I was able to accomplish two interviews in this time period. I also stayed after school more than once to obtain information and talk with students and teachers, both formally and informally.

Themes

Spradley argues that a cultural inventory is achieved partly by synthesizing cultural domains from observations and mappings of scenes participated in or systematically observed (1979; 1982). Were this a closer approximation to a full-scale rural high school "ethnography," themes and theme analysis would be a part of the larger ethnographic study. The general format of this work has been to rely on such a qualitative research strategy, but one that falls short of attempting to systematically map the larger public school terrain and to discover its greater cultural parameters. The focus has intentionally been preconceived to dwell on how academics and mathematics is constructed in the schools in question, which by no means even begins to assess the huge range of cultural and subcultural dynamics of the modern American high school.

In the following pages, I attempt to depict how mathematics is constructed in the two schools I investigated. The sorts of entering frames of reference and questions posed are earlier discussed. In much of what follows, I use the words of students, teachers and administrators in each school to articulate how they understand what math is about, who teaches it, who is perceived to use it and why, etc. I try in the following pages to give some general sense of the themes that emerged in the fieldwork across both sites, but also try to qualify or elaborate on differences between the schools as well. I am allowing the following comments to suggest themes I found in many cases above and beyond the interviews themselves.

Themes Related To Rurality

Readers of this monograph may not have considered what difference living in a rural community might entail for local high schools and for instruction. I considered this question particularly important given that much of the education literature has historically considered rural communities somehow disadvantaged with regard to possibilities for young adults (Tyack, 1977; Fuller, 1982). Although state departments have often argued that rural schools are disadvantaged, the many educators I talked to for this work interpreted, and stressed, the advantages of rural high schools. The comments of a guidance counselor at one of the schools in this study are illustrative:

> AD (Alan DeYoung): … When I mentioned that some people argued that rural schools are different from other ones, you lit up to that. Maybe, can you tell me why you think a rural high school may be different than some other high schools - what would you say about that?
>
> ML: Well, I guess that I look at it mostly as advantageous because in a rural school, in a small school, you can pay so much more attention to those kids. You know them, you know their families, you know where they come from. You can really know that whole person and not just see their name on a paper and know what they've accomplished academically. You can really see something there in those kids. And I think that happens in small towns. Now, [when] I was a student and I graduated from [LCHS], … I'm not sure I looked at that as something that was good, because, you know, whenever you're a kid you want … you don't want everybody to know everything about you. So, I'm not sure that those kids feel the same way, but as an educator, I feel that that's a really big positive. [One of her two children attends] _____Elementary and one [attends] the middle school. And I know _____ Elementary is a small elementary school, but I think it's wonderful that the principal knows every single child and can call them by name. I think, I just think there's so many wonderful things to that. And whenever I was growing up, I went to school in Louisville until I was 14 years old, and I got a lot of good things there. One of the disadvantages I think of being in a rural school is that we don't have a lot of programs that a larger school would have, or a city school would have. We don't have those resources to draw on within the community necessarily. We have our own, but we don't have as many probably. We don't have, you know, we don't have those kinds of, we don't have the diversity. And again, some people look at that as a positive. I don't know that that's really a positive for our kids to not be more diverse. I wish that we had more diversity. So, you know, it's a trade-off, I guess. I think our kids fair real well. You just have to work extra hard in other areas for those that you don't have.

Meanwhile, one of the teachers in this study who had grown up in the other site had positive, but for him, troublesome, opinions about implications of rurality related to current academic concerns of his. These views also related to potential understandings

of the relationships between future careers and schooling, and began with a question about local teachers and their community ties:

> CP: We do have a degree of mix. I would say primarily a lot of our instructors are from this area. I don't know, I think there could be several reasons for that. Partially there are family ties and wherever you have family ties people are often lax to leave it. I think also, in my case, at some point in my college career thought that I don't really want to live in a city. That doesn't fit me very well and I had a drive to come back to this school to try to help the students achieve what they needed to, and I would say there's probably several others that have that same feeling. And then there is also a quality of home. People, especially in rural areas, I think, become very attached to home, whatever that home is, even if it's 30 miles from where they were—if it's in the same county that seems to be home to them and they become very attached to it. As far as ties to the community and the interaction between the community and the teachers themselves, um, just like any population, you're going to have some that have much more interaction then others. Some are very involved in the community. Some are outside the community. We do have several teachers who commute for approximately an hour; as such, they don't have a whole lot of local community involvement outside of the school. For the most part I think teachers outside of school are treated as having a position of respect as you would from other professionals in the community. ***However*** [emphasis added], they are not approached about school questions. If they're approached it's about whatever else they want help with—the lawnmower or whatever it is. It's something other than a school-related thing. I have never had a single person outside of school ask me anything about school itself. So, it's a clear break between the two. They don't see the interaction. It's almost as if the school environment is a sub-culture of the greater community environment and the interactions, they're almost mutually exclusive, which is not the model that we're going for. We would rather have more of the community of learners environment versus the mutually exclusive environment.

The LCHS guidance counselor also talked about the importance as well as the dilemma of place for rural high school students in Kentucky. (Implications of this dilemma for the curriculum will also become clearer in later interview passages.)

> ML: Yeah, you hear 'em say "I'm never coming back here after I'm leaving and I'm never coming back here after I graduate." I was one of those children who said that when I was a senior. "I'm getting out of here and I'm going to so and so … and I'll do this." Then I was back in a few years 'cause after you get away you miss that closeness and that community. You know there's a family here that embraces you and you want to come back to that. You want your kids to have that. So, yeah, we have lots of that.

Another common positive value of rural schooling in the eyes of several informants is suggested in the passages that follow: In contrast to their understanding of urban and larger schools, they felt that discipline was not a major issue in their buildings. Part of this reason was sometimes attributed to the remaining importance of family and church for many rural kids. The LCHS Teacher Partner (whose roles are discussed in

the following pages) responded in this way to my query about rural and education. Although she was from the adjacent, rural county, many of her experiences had also been in urban Florida schools:

> BO: Well one of the big things that's not the same is the family. The family that I saw in poor urban places was very fractured, very nuclear, non-supportive, the custodial parent having as many problems as the kid having. In the rural setting the family usually [functions] as intact even if it's not. It's a single mother, [and] she has other family that's helping her out. She's got brothers and sisters and mothers and aunts and cousins. In the urban areas, the church did not play a real role. They tried and they did a lot of good work, but they weren't the central, they didn't occupy the central-ness in a family's life that you get in the rural population. Those are two for starters and that makes a huge difference to kids.

On the other hand, the century-long transformation in rural life was viewed as quite problematic by some long-time educators interviewed here. Many young people, it was suggested, were harmed by the economic decline and demographic transformations of their rural communities, because in many families, with the decline of family farming over the past decade or two, opportunities to learn responsibility at home also had declined.. Even *within* these two rural counties, demographic shifts have seen families and children from outlying areas move toward the county seat and other population centers, partly subsidized by state and federal housing programs. A former RCHS administrator bemoaned the impact on the students at his school:

> FM: We're a rural area—there weren't a lot of big farms, but everybody—when you drove down the road most people had a cow or something. There was some kind of agriculture going on that they were directly involved in. There weren't housing complexes where people lived, which limits the amount of employment opportunity or employment experience or work experience. Now [kids] really don't have an opportunity cause they don't have a place to learn to work. And, therefore, parents don't really have a place where they can teach them work and responsibility. The biggest thing they may have to do is take the garbage out, you know, if they live in a housing complex. So, you know, that's not a lot of responsibility for them to have. And I think that's transferred into a lack of not just responsibility in working, but they're just plain lazy. They think they don't have anything to do and they just sit and watch video games for hours and hours and hours with very little physical activity or responsibility unless somebody's paying them to watch video games. I think that's probably about the biggest change that I've seen in kids and I think that's probably true in other places not just in this community. I think that's something that we the parents haven't done a good job as our parents before us did.

Themes Of Regional Poverty And Economic Development

There were interesting differences (in degree at least) as well as similarities between the two counties in this study as viewed by school officials and many students. In both counties, poverty was high. Rural poverty, though, is almost assumed in county school systems of Eastern Kentucky. More than half of the young people in each school studied here were from homes below the poverty line and could qualify for free and reduced price lunches. Depending upon the source, estimates of those eligible for free and reduced price lunches ranged from 50% at LCHS to a reported 60% by school officials in RCHS. Both schools had a Youth Services Center in their schools: referral and support centers for schools with significant numbers of "at-risk" kids in each school. The centers were made possible under the Kentucky Education Reform Act (KERA) of 1990.

Although rural poverty was a background frame for both schools, there were difference expressed within the schools and communities regarding future economic possibilities. River County informants more typically portrayed their county as historically marginal in terms of the local economy, and did not foresee any dramatic local turnaround soon. School administrators at RCHS thus generally seemed to assume that almost any motivated young person in River County would have to leave home to find gainful employment—either leaving the region entirely or at least migrating to the more economically viable small cities an hour to the west, east or the north. The object of helping students gain academic or vocational skills, then, was to help them leave the area. The former county superintendent at RCHS agreed that college-bound kids usually left the county permanently after high school, but even graduates of the technical and

vocational programs had to become at least regionally mobile. As he described employment possibilities in the area:

> FM: Well, in the last any number of years, probably at least six, we've been in the top 10 if not in the top two or three of unemployment in the state where the county's concerned. We've never had a lot of employment available, readily available in our community. People who have lived here in the past had to travel outside the community if they were going to stay here. As far as higher-level paying jobs or those jobs requiring higher levels of education outside of teaching, a few lawyers, a doctor or two, a pharmacy or two, you know, those are about it as far as jobs that require that level of education. Unfortunately what we've been over the years is a provider of people to other places. Our more educated had to leave to find employment. So that's left us with a base that has a lower level of education, you know logging, the logging industry and that sort of thing has been the major employer outside of the school system. For a time we had a US shoe corporation and were a big employer, but those were at the very best low-paying jobs. So, we had a high rate, always have a high rate of people that participate in free and reduced price lunch program. I can't think of the percentages right off hand, but it's a high rate in the state, so that's always been a problem. Our people don't have all the opportunities that some other people have in different areas. … As far as any drastic changes I would say in income level I doubt you'd see that if you looked at census figures over the years. We've been an isolated area due to roads. If you look at River County on a map, a road map, all the roads for years—they didn't go through here, none of the main roads. … So, that's held us back.

School officials in Lakeway County, though, described a more diversified local economy that was tied in important ways to regional job growth and to nearby college and university programs, and was the scene of several interrelated regional improvement schemes and strategies. There were often pronouncements at the school that locally decent employment was possible if the community kept working hard to improve the local economy. The school district was also involved in several public and private education-related linkages, including significant linkages to regional colleges and universities. Importantly, a major figure in the Lakeway County economic improvement efforts was the former school superintendent, who was also credited with transforming the entire school system for the better a decade previously. The school web site makes special mention of their various innovative programs and connections to local, state and national programs and organizations:

> [LCHS] is a High School That Works and a Making Schools Work site. In 2002, 16 students received the Award of Educational Achievement for meeting SREB goals in reading, math and science. LCHS is a

> member of the Tech Prep National Student Registry. LCHS participates in School To Work and School To Careers initiatives and is a Character Education pilot site. We are a 21st Century Community Learning Center, and have been awarded a Gear-Up grant to help 9th graders make a smooth transition to high school and to help prepare students for postsecondary education.

In May of 2003, the LCHS Principal brought in a motivational speaker for students during the week of the state high-stakes testing (CATS), which will be discussed shortly. The idea was to convince the students that their hard work was not only important for their futures, but for the future of the communities in the county as well. The speaker was from a regional community development group that was also involved with other business and educational groups in the county. Speaking to the entire student body of LCHS (in two shifts), he argued:

> HL: When you think about the future or you think about creating the future, you need to think about two things. One is you need to think about the things that you want to change; equally important is to think about the things that you want to keep, and that's a balancing act. This change is going to happen. Change always happens, but you may or may not get the change that you want to see. In fact, if we just sit back and see what happens, we're most likely going to get the changes we don't want to see. If you look around you, you know what those changes are—higher crime rates, things going downhill, clean water and clean air's getting worse, losing our natural beauty and our natural resources. Those are things that are important to preserve. At the same time there are things that need change. You all know you need to have a driving economy, you need to have better jobs, and Lakeway County's on track for that. In addition to [the interstate], you've got Retro Valley [a country music performance location and campground]. This is a fantastic resource that can be expanded on. I work with communities all over Eastern Kentucky and West Virginia that look a lot like Lakeway County: they've got hills and streams and trees and they say "we'd like to promote tourism here," but there's no structure to support tourism. There's nothing for tourists to come and do. You all have got a tremendous advantage there, but that advantage needs to be built on. You've got a hospital here in Lakeway County that's the largest employer in the county. I can't tell you how unusual that is. Most communities the size of [the county seat] have lost their hospitals because they can't compete with the big cities. What the hospital here did was to develop a niche market in long-term respiratory care. Believe it or not they do it better then anybody else in the state. People come from all over Kentucky for long-term respiratory care here. There are jobs in health care and they are some of the best paying jobs in the United States. You've got a resource here, but it needs to be built on. You come into this with some tremendous advantages and you have yet another advantage and that is that your county has a plan. Now, many counties have plans, in fact, most counties have plan. The problem is, most of those plans—and they're pretty good plans—most of those plans are still in stacks, in boxes on the shelves just the way they came back from the printer. One thing to make a plan, another thing to make a plan happen, and that's where you come in.

Themes Related To School Leadership

Both of the schools in this study report dramatic changes in school focus and school leadership during the past decade. One district apparently transformed itself in the late 1980s; the other a bit more recently. In each case, a focus on academics and academic achievement for students that previously might have been ignored or overlooked seems to have been the theme.

> ML: We have a very strong academic base here. We are very progressive as a school, and I think our students know we have high expectations for them and they can perform. They are … a very well behaved group. We don't see fighting in the halls … we had a big turnover in this county as far as focus goes. There [were] some political events that occurred and as a result we had a new superintendent. … and he was just an incredibly intellectual and visionary type person. I think that was the beginning. He was a visionary. That's probably the best way I can describe him. He always looked ahead. He was very well read and he had a progressive stance when it came to our education system. And so, he, I think, started that. And whenever he retired, by that time he had made sure that we had that focus as well. And we've just tried to maintain that focus throughout. And our superintendent now, _____, is also someone who's more progressive. He's someone who's interested in, you know, being, you know, one of the first ones, I guess, to accomplish whatever's coming down the pike. So, I think that that has a lot to do with it is our leadership. We do have principals here in our county who are focused as well. And who are people who are life-long learners themselves, and I think that that has everything to do with it. I think that that's probably it.

In another interview, the current principal of LCHS reports that he dedicated a great portion of his life to improving his county's education system after he learned of its low appreciation in the region from teacher educators he studied under:

> HA:- Yeah, I remember when I was in college I just graduated and I was working on my masters degree and I was attending classes at Eastern Kentucky University and I was finishing my program and the department chair asked me to come in and meet with him one day and he was trying to encourage me to go into the doctoral program or specialist program and he asked what I was going to do. I told him I was going to stay in Lakeway County and teach and go into administration. And he told me at that time he said "you don't want to be there: it's just a dead end job." And that was just the attitude that people had about us. It really bothered me that it was that way. So I said it was one of my goals to see that changed. Certainly a lot of other people did as well. We haven't arrived yet, we are not where we need to be, we're not going to rank with Anchorage [Kentucky] or some of those types of places. Not Mason County or Oldham County; but that is our goal—to get up there in that category.

The school districts involved in this study have a sustained history of school improvement over the past decade or two. The statewide reform efforts in the past decade have at least partly facilitated this change. In 1990, the state of Kentucky began

an intensive period of school reform under the Kentucky Educational Reform Act. The Act was the result of litigation against the state by sixty-six property-poor school districts like those of Lakeway and River Counties. In addition to completely overhauling and increasing the fiscal support system of all Kentucky Schools, it also introduced a new accountability system, KIRIS, or the Kentucky Instructional Results Information System. This assessment was subsequently modified into the current Commonwealth Accountability Testing System, or CATS.

Throughout the 1990s and into the current era, all Kentucky schools are held accountable for increasing standards in various academic and retention performance areas. Every two years, each school is judged as either being at, behind, or ahead of the mandated performance curve, based upon its own baseline and previous biennial assessment. By the year 2014, all students in each Kentucky school are required to have all of their students in the top two categories of the state assessments: either "Proficient" or "Distinguished." The lower two categories are termed "Novice" and "Apprentice." Although in national comparisons CTBS test scores suggest these schools are below average in some academic areas, both RCHS and LCHS have either met or exceeded their school-wide target scores under the *state* accountability system since 1995. In fact, a large concern at both schools was that dramatic early gains have become harder to sustain than was anticipated. For schools statistically ahead of their performance mandates, the state created a category of "School in Rewards," and various amounts of extra funding for such schools were given. Both LCHS and RCHS were in the late 1990s among those winning awards; but both schools have since seen their increases moderate. How this translates to increased efforts in mathematics will be discussed shortly.

Tables 1 and 2 are from a national web site that profiles all Kentucky public schools based upon US Education Department data (http//www.greatschools.net). Table 1 attempts to describe the general accountability parameters and consequences for meeting or not meeting state achievement goals by district. Table 2 presents state accountability data on Math and Reading for each school. It should be point out that in several comparisons both RCHS and LCHS are below the state average; the accountability profiles and mandated improvements are charted from baseline data relevant to each school (from 1991), however, not against state averages. As well, both schools have higher percentages of students from low-income families than either state or national averages. There is also some discussion about Kentucky Core Content in Table 2, which becomes important in later discussions of Algebra coursework in both county high schools.

TABLE 1: ABOUT TEST SCORES IN KENTUCKY

The test score information for this state is from the 2000-2001 school year, which is the most recent data available from the U.S. Department of Education.

Although test scores are only one measure of student achievement, they have become increasingly important in assessing student learning. Kentucky's Commonwealth Accountability Testing System (CATS) includes both a national, norm-referenced examination and several state- level, standards-based assessments. The CATS can therefore be used to compare the skills of students in Kentucky to those of students nationwide and to measure whether students are mastering the specific skills defined for each grade by the state of Kentucky.

What does CATS include?
Kentucky administers the national exam, the Comprehensive Test of Basic Skills (CTBS), in grades 3, 6 and 9. The CTBS assesses reading, language arts and mathematics skills. Among the state level assessments are the Kentucky Core Content Tests (KCCT) in reading (grades 4, 7 and 10) and mathematics (grades 5, 8 and 11), as well as a separate assessment of writing skills (grades 4, 7 and 12).

Why does CATS performance matter?
Although Kentucky does not mandate that schools use test scores to make decisions regarding grade-level promotion or retention, individual schools may take CATS performance into account when making such decisions. In general, standardized test scores that are below proficient are one factor that might indicate the need for additional assistance.

CATS performance is important to schools because it is the principal factor that determines the accountability score assigned to each school by the state of Kentucky. These ratings can have substantial consequences. Under-performing schools are given additional funds to encourage improvement and excellent schools are eligible for additional funding to reward their success.

Table 2: LCHS and RCHS Kentucky Core Content Scores

- (About the Tests)
- State-level assessments include the Kentucky Core Content Tests (KCCT) in reading (grades 4, 7 and 10) and mathematics (grades 5, 8 and 11), as well as a separate assessment of writing skills (grades 4, 7 and 12).
- The KCCT and writing test are standards based, meaning that they measure how well students are mastering specific skills defined for each grade by the state of Kentucky.
- Kentucky assigns accountability subscores ranging from 0-140 in various subjects. These subscores based on test scores, in addition to other factors such as attendance and dropout rates, are used to assign an overall rating (not shown).
- (Scale: Accountability Score (the goal is 100)

RIVER COUNTY HIGH SCHOOL

Math

The state average for high school math was 59 in 2001.

Reading

The state average for high school reading was 68 in 2001

LAKEWAY COUNTY HIGH SCHOOL

Math

The state average for high school math was 59 in 2001.

Reading

The state average for high school reading was 68 in 2001.

For almost two decades in LCHS, and for slightly less time perhaps in RCHS, the pressure (or the opportunity) to focus more on learner outcomes consistent with aims of the state have been emphasized. The current principal of LCHS's sentiments on this were mentioned above. The former county superintendent and now part-time administrator at RCHS talked a bit about changes in focus this decade at his school. His sense is that building principals have been called upon to develop a greatly expanded role in school leadership than used to be the case:

> FM: Well, I think probably the biggest change—I know the big change—is principals going from being just overseers and lecturers and how things are organized to really structured leadership. … It's hard to do all those things, you know. … I'm not sure that everyone [principal] enjoys it, but I think they're a lot more comfortable with it. And that's a good thing. When I was principal, unfortunately I didn't know how to help people be better teachers. I really didn't want a math club. Sometime in the mid-80s—when I kind of got retrained in my thinking process—I got re-tooled, so to speak, and realized that there are some ways that you can help people. Before that I thought either you could or you couldn't. And we, over the years have been able to talk to our principals and they've gotten a lot better and a lot better. So I think that's another big change.

Meanwhile, the sitting principal at RCHS had the following to say about the state accountability system, her agenda, and her perceptions about math success. I use the word "sitting" here with some temerity. EN seemed to spend most of her time out and around the building at RCHS, and could rarely be found in her chair during my visits:

> EN: It's probably, I mean, well if there's a Kentucky principal that isn't aware of [accountability mandates under KERA], they're fools because they'll be out next fall. [But] if that's the measure we're held accountable by, I think we are more than those scores, but you have to be worried about that measure. Women are more than their weight and their dress size, but they're very worried about that measure, because that tends to be, the analogy I guess. That's what folks pay attention to. Well those CATS scores are what folks pay attention to. And—we were successful last year and what I found successful meaning [is that] we made some gains. We actually exceeded our goal. Mathematics made probably some of the biggest gains that we made. But what I find is success breeds success. The better we do, the better we want to do. So while CATS is a measure and the measure didn't put my neck on the chopping block - and that's a good thing [since] meeting the goal feels good, but the forward motion for having been successful is to me far more important than the number. I mean, are we where my vision is. No, not at all: we're closer.

Math Teachers In The Forefront

In both RCHS and LCHS, the mathematics departments were viewed or "constructed" as critical to the overall strength and mission of the school. This is not a huge surprise, considering that math CATS scores were high; there were seasoned veteran teachers in each department; and they were understood by many of their colleagues to be under some sort of sponsorship of the National Science Foundation. EN, the RCHS principal earlier quoted, was greatly impressed with her math department, and in particular, with two of the five full-time math teachers. Both had been in the school for some time. She continued to hope that their commitment to enhanced academic achievement at her school would permeate other teachers and departments at RCHS. Her understanding of the curricular dynamics and needs of the math program was particularly interesting, as her background was not in math or science, but in nursing and elementary education before she came to RCHS. She could articulate the curriculum and its focus without hesitation. She also mentions in the following several important issues and themes that will be discussed more fully in pages ahead. The quote here, however, is intended to highlight the sorts of new leadership knowledge that the former superintendent (FM) previously suggested:

> EN: We have some of our kids take algebra at the middle school, and this is probably going to be the last year for that. We're not real sure that it works real well for them and for us. And part of the kids take algebra here. If they take Algebra I here this year we moved it to off the [regular block schedule]. … So they have a full block of Algebra one day and a part of a block the next day. So they now have algebra every day. And that's new for us this year because Algebra I contains an extraordinary amount of foundational kinds of ideas that we just can't get done if we don't do it [this way]. Or certainly the students would struggle with math. For those students that take algebra at the middle school, they go into accelerated geometry or geometry, but they also have to sign that they will take a third year of math here in this building, which means pre-calculus or better. [Next] in the sequence is Geometry or Accelerated Geometry and then Algebra II or Practical Stats [statistics]. For students who have struggled mightily with geometry, we will offer them [Practical Stats]. [It's] basically the same work content, well it's required for content [by the state core curriculum], but we take a little different approach. A lot of it [is] more hands-on if they struggle with the abstract or symbolic nature of it. Pre-calculus is one of our electives. And this year for the first time in several years since I've been here this year we offer calculus.

EN believed that at least a couple of her math teachers and the department as a whole had the potential for being a demonstration site for schools outside of RCHS. The math department met routinely, and one of its regular functions was to "peer review" or constructively critique each other's lesson plans and teaching strategies. The principal found this practice extremely helpful, and word got around about it. One week when I was at the school, a plan was announced to demonstrate the process over at the middle school, which seemed to be having some problems with math achievement. EN seemed pleased that other schools might also want to see how her teachers accomplished this peer review:

> EN: I mean one day I'd like [RCHS] to almost be a lab site for mathematics for pre-service teachers. Now we do have some folks coming in [to observe us], but I mean I want to be THE lab site in mathematics. That's what you're talking about. In more than mathematics, but—mathematics is important. I mean it's just important! It's a basic foundational kind of skills that you need to go on and do other things as well. It's a lot of it. And if we teach it right the kids progress. … That's a piece of [my] vision of the math department—like the whole school will be like that for people who are looking at what to do. They'll give out the name of River County High School. And it's not a glory thing. I mean, because I don't care about that. I don't want to, being seen is something that I like, but that's my goal. That's where I want us to be.
>
> AD: What would you have to do to become the model for math? From where you are what has to change or be added to? How would you go about doing that?
>
> EN: If everybody here … Have you watched _____teach?
>
> AD: I've interviewed her [and] sat in a little bit, but I haven't been there the whole time.
>
> EN: If I can get everybody to that level. … _____is another one of them, and they buy it. They have a similar vision. They want the same thing.

Although emphasis on math achievement in River County seems reported as a combined interest of administrators and teachers, Lakeway County informants identified the former superintendent, the highly cohesive math department, and external connections to NSF programs as providing the base for math teaching success. Math teachers at LCHS seemed to differ from their counterparts at RCHS with regard to their internal organization. Math at RCHS was offered in different places throughout the

school, and teachers were dispersed to different corridors and wings of the building. LCHS math teachers, on the other hand, were highly concentrated and departmentalized. They had their own wing; their classes were all proximate; and they shared a former storeroom, which they had turned into a lunch and meeting room. HS described the scene thusly, also mentioning another Math/Science program run by the federal government via the Appalachia Education Laboratory (AEL):

> AD: Do you guys work together as a department pretty regularly? How does that work?
>
> HS: We work together all the time. I'm together with this department as much as I'm together with my husband. … we're part of the ACCLAIM project and part of ARSI and part of AEL. We have AEL meetings. So we're together quite a bit. The math department eats lunch together everyday. Now my husband teaches here and he's got first lunch so a lot of days I go down there and eat with him, but the rest of the department eats together.
>
> AD: And what kind of things … do you talk shop at lunch?
>
> HS: We—sometimes we talk math and sometimes we don't. A lot of times we do talk about things going on in the classroom or [the department chair] will let us know different stuff that's going on or when we're going to have meetings or what we need to discuss about a meeting. And then sometimes we just eat and talk. A lot of days we're down there talking about things that's going on.

Each of the schools studied here was home to one or more key players whose positions were either partly or fully funded by the National Science Foundation (NSF) via the Appalachian Rural Systemic Initiative (ARSI). ARSI, the first of several math and science improvement projects to be found in many eastern Kentucky high and middle schools (including ACCLAIM and AMSP), had developed a network of participating teachers and "Teacher Partners" for enhancing math and science teaching. Reminiscent perhaps of the ministerial circuit riders of old, Teacher Partners worked either with staffs of regional high school science or math departments to bring to them latest technologies and methods for improving learner outcomes in these areas. LCHS had a full-time mathematics Teacher Partner; RCHS a full-time science Teacher Partner. Each of these experienced teachers worked in several schools; each knew a lot about teaching issues in

both schools. In addition, RCHS had a former math teacher who was a half time Teacher Partner in math. Her other duties were as assistant principal, where she shared disciplinary and administrative duties with another staff member. This was designed, reportedly, to enable the principal to undertake her extensive curricular supervision duties.

The math Teacher Partner in LCHS was long-time regional resident and teacher from an adjoining county. She, too, argued that the early thrust for math improvement came from the former superintendent, was carried forward by the past and current principal of the high school, and involved enabling and rewarding "forward looking" instructional strategies:

> BO: Well, Lakeway has been one of the premier districts in the states since KERA. They had a superintendent named _____, and he was—he was a surprise to everybody. Nobody knew that [he] was a liberal-radical at heart 'cause he was in this system and all. When he was superintendent he went outside this county, he went outside this state, I mean they were part of the Schools That Work early, they were part of—what's that group out of Brown University? You know what—I mean they went out, sought out these programs and went to work. In fact I was doing a little consulting one summer over here and I sat in a meeting and heard the man say—'cause this little sweet little elementary teacher said, "Oh Mr. _____ I'm scared to death to try this. What if is doesn't work?" And he said, "Well if it doesn't work we've learned something. We'll try something else." I mean he was that kind of open. So they have been working really hard for about eight or nine years at being forward-looking beyond the box, trying new stuff. And they've been encouraged to do that. So they've done a lot of that kind of thing. They've had a lot of money because they were making such gains that people were throwing money at them for a while, that's dried up a lot, but they got to buy a lot of technology and that sort of thing.

<u>Developing And Replacing Math Teachers</u>

A theme that emerged in both schools in the course of this project was how hard it was to replace math teachers with certified specialists who were also committed to school wide systemic improvement. In the case of these schools, both principals and the Teacher Partners dedicated to working with staff argued that these schools were currently quite fortunate to have weathered turnover issues well in the math department, unlike others. Both principals were satisfied with current math teachers; one more so than the

other, perhaps. The Teacher Partner for LCHS considered that school's principal a math-dedicated administrator who understood the issues and provided the umbrella required to sustain her professional development efforts. Her job the previous year had been to work intensely with the school's three new math teachers who had just joined the three veterans under sponsorship from ARSI:

> BO: And that's one of the reasons that they hired me last year. I worked in this building two days a week all the second semester. And mostly it was a lot of hand holding and team teaching with the new teachers. And what we would do is, I would come like on Wednesday … and I would visit with them during their planning period. I had the three new teachers, and then if anybody else wanted anything—like _____ and I did a wonderful matrix problem together that we worked on 'cause he was interested in finding a good matrix problem—and so I did that. I visited with them on Wednesday and they would tell me what they would be doing the following Tuesday—it was usually Tuesday and Wednesday—and we'd talk about how we could put some technology or some manipulatives or something different in the class. And then I'd go back and get it together. And if it was first period, then I'd be here really early. We'd meet early in the day. I'd have emailed the stuff to them. We'd meet early in the day and practiced a little bit. And then we'd team teach that lesson. And that would be on Tuesday and on Wednesday I'd come back and talk to them about how they thought it went and what they were going to do the next week and how we'd, you know. That was what I did last year for them. So, and they're still using lots of that, but we need more than that now. We need some more of that, but we also need this other stuff, thinking about it. … It was just really nice because we had a lot of fun, and the three new teachers - one was not only new to the system; she had been a counselor in [another county] but she'd been a counselor for several years so she'd been out of the math classroom and had never taught geometry. So it was like being a new teacher. So her and then two [other] women who had come to teaching as second careers—but I don't care whether it's your second career or your first career, that first year's a real bear. We all just thought we weren't going to survive. So that's what I did, and I had a really good time.
>
> AD: So right now, do you consider all the teachers to be up to speed in the high school here now?
>
> BO: Yes, I do. They're really lucky because math teachers are hard to find. Now I would say that probably [one of the veteran teachers] has the best background for teaching upper level classes. If anybody else took on one of those upper level classes, they'd have to work awfully hard.

At the smaller RCHS, finding a qualified and credentialed math teacher was a trickier proposition. By some accounts, one of the younger and better math teaches in the school had been lured away from River County by a larger and wealthier district to the west. He was replaced by a middle school teacher from Ohio, who was technically teaching out of field. Rumor had it, parenthetically, that the former teacher lost to higher salary elsewhere wanted to return for the 2003-2004 year. He was reported to be willing

to forsake some of the higher pay in his 2002-2003 job to return to more familiar turf back in Lakeway County.

The state of Kentucky has identified out-of-field teachers as problematic, and all schools, including RCHS, are under pressure to either get them certified or to replace them. Thus, attracting and screening new teachers is an important matter, to which the ARSI Teacher Partner in RCHS attested in 2003. She comments here on the overall quality of math and science teaches at her school, what things she is working with them on, and the active involvement of the principal in finding the right people for the job:

> JS: For the most part [teachers'] hearts are in the right place. They've worked really hard. They care about the kids. They know the content. So now it's getting that—putting all those together in some form—in some lesson design, unit design. that's appealing to the kids; that gets them engaged and involved. … So that's, we're looking at how we do this, how can we give them study skills, how can we help them with research skills, that sort of thing.
>
> AD: Is there a climate in this high school that supports, I mean at the level of the administration that supports the stuff that you're doing? How would you describe that?
>
> JS: Oh yes. We have great administrative support from our central office to our principals, assistant principals, and I think that's why it's happening. If you have—we have that kind of leadership that looks at—"okay this isn't working what do we need to do? This is working: let's enhance it or keep on doing that." Our principal stays well informed, she's well read and she brings stuff to us. But she also is wise enough to know that we have to have faculty buy-in, so it's faculty decisions. It's not imposed or dictated to do this. And I think in the new hirings—I've been in on a lot of the interviews—and she makes it explicit to anybody new what the expectations are when they come in, you "do these things." She also—we've had some success with the reading program that we implemented, and we learned from that that monitoring the teachers paid off. It wasn't ah—"we're checking up to see if you're doing your job," it's "can we help you," " how's it going," that kind of thing. And it paid off very well. So we learned that kind of monitoring what we're asking people to do is important. So she's been monitoring implementation of the strategies of everybody's agreed to try and that kind of thing. And I think that people know she's going to be asking.

Teachers Interpret The Teaching Of Math Today

Teachers and those who work with teachers in 2003 at the two high schools under discussion explain that their undertakings are quite different from what they use to be (for those who have been teaching more than a decade), or different than they understand the job used to be in the pre-KERA days. Most teachers interviewed thought this was a good

thing; many thought it led to lots of extra hard work; some also opined that current emphases interfered with emphases and programs they would like to undertake, had they the time and backing.

With regard to relatively recent changes in teacher strategies, the chair of the LCHS six-member math department had this to say:

> AM: Yes, [teaching] certainly has changed—especially for me. [overall] I think it is a lot more emphasis on activities, hands-on activities, as well as applications of math, I think that is stressed much more now than when I started teaching. I can remember beginning teaching, algebra was very algorithmic: you taught how to solve a problem. Maybe it was my lack of experience, but now there is a great emphasis on being able to apply what you have done, be able to understand situations that would relate to your topic. And so I think that emphasis on technology and manipulatives and activities or things - that's changed math a great deal. Actually geometry—I haven't taught geometry—but from taking geometry in school, I can remember that being a very proof-oriented class. Two column proofs—whatever—and the applications of geometry are much more real now.

Much of the recent emergence of "applications" and "manipulatives" mentioned above is reported to be a function of the state and now national accountability demands felt in all school programs, including math. The LCHS ARSI Teacher-Partner talked about the needs and what she considered the focus to continue to be in order to bring up student math performance in years ahead:

> BO: … I've always used KERA as kind of my reason to get done what I wanted to do anyhow. And they're [teachers] kind of that attitude. Some people say "well, I don't know whether to do that" and you say "well, you know the math scores are not going to go up unless we do something." They're very aware and it's forced them, and it's not just here. It's all over Kentucky. My kids all went to school in Florida. I taught school in Florida. It was there, too. I can speak to that. We did a really good job with our gifted, good students. We did a really good job with our special needs students. [But] we let a lot of these kids fall through the cracks in the middle. You can't do that now. I mean George Bush's "No Child Left Behind"—he's aiming at the wrong problem. The problem is all those kids in the middle that turn out to be your good citizens of the world. We haven't—you know—they've never given us any trouble. They just kind of rock along. You know the kind I'm talking about. Well now we're really trying to give them a better education. And they're the ones that I see in the grocery store and show me their kids and talk to me about using math in their jobs. "Well I thought you were just crazy when you said that"—you know?

BO was among the many teachers who talked about the value of "manipulatives" to encourage learners among those who allegedly had difficulty learning math due to its

claimed too-abstract properties. She was a big fan of manipulatives, and helping the teachers she worked with at LCHS learn how to use them, too, was one of her tasks:

> BO: And, of course, I am prejudiced—I have to say upfront that not everybody agrees with me—but I use concrete manipulatives: go out and pound stakes in the ground kind of stuff. I think all kids learn better that way. But your reluctant learners really learn a lot better that way. That's how I teach them about [theorems]. We go out and have to make a square or rectangle from year to year. I vary it to make myself more interested. I give each group three stakes and a rope and they have to figure out how to make… ["pretend"] the concrete truck is coming—and they've got to
> figure out how to square it up. And it takes 90 minutes but they finally get to it, and they don't forget it.

The principal at RCHS also believed that manipulatives and movement were keys to enhanced math achievement for students at her school. She claimed that her vision of school success probably involved emerging strategies and techniques that she did not experience herself as a student. She phrased it thusly:

> EN: I believe in math by concept development. Manipulative is such an overused word, but letting kids move it around … making sense … seeing what it looks like before you go to a pencil and paper. And that's what I taught [in her year's teacher education experience]. And so I very much believe in it because I understood for the first time as I began to do that. And I think it's critical for a kid. For it not to just be pushing numbers around page to page in a textbook. And when we're no longer textbook bound, that'll be a part of the vision. I mean we push very hard for an everyday-like approach, which is, you know, wildly successful if you can eat a couple years until you grow into it kind of thing. But I'm going to push real hard.

Articulating Achievement/Ability Levels

Both schools had small programs for special needs math students. Teachers for these children had other duties as well, and thus did not appear to be central figures in the efforts to improve math instruction in the schools or to provide math teachers with professional development from the outside. In effect, both schools in this study have created (or continued) a two-track academic system, comparable to that cited in the literature referred to earlier in this report.

In both schools there is an accelerated, or more academic, set of classes, and general, or non-accelerated, classes. Importantly, these two groups are reported to be

about equal in number, and there is rarely any talk about students who cannot find a place in one or the other group. "Drop-outs," probably a ringing concern in either of these schools only two decades ago, were rarely mentioned in interviews I conducted. Most students appeared to finish school in these two communities, either in one track or the other. School practices may or may not have changed much, but retention has apparently been enhanced.

Each school's math curriculum had different course titles except for algebra and geometry. It became clear that part of this reason is that the math training, along with suggested or inherited course titles from national associations that have become part of the lexicon of schools, are not tightly coupled with what drives learning outcomes in Kentucky today: the Kentucky Core Content standards. State requirements are for grade level content without the overlay of titles like "algebra" or "calculus." The schools package the content in titles they have likely used over time. This allows different high schools to teach similar things, but to call them by different names.

HS, who teaches several sections of courses called "Integrated Math" and "Data and Measurement," describes the boundary issues between such topics as Algebra and Geometry. The Integrated Math sequence (1, 2 and 3) mirrors Algebra 1, Geometry and Algebra 2 for the theoretically non-college bound students (see below). Data and Measurement is a semester-long course that undertakes at LCHS to complete other Kentucky core content math topics:

> HS: Data and Measurement in this school is kind of a course that's put together to relieve some of the stress on the geometry and on the algebra II classes. Its taken concepts that we felt we weren't covering real well just because we didn't have the time in those other courses algebra I, algebra II and geometry. It's pulled that into [a] data measurement course. And so we've just broken down the core content to the Kentucky standards and tried to assign everybody.
>
> AD: So the core content doesn't specify how you have to organize the math instruction. It just has a big laundry list and you can figure out how to that. Is that right?

> HS: Right. … Well, the state of Kentucky requires that students have algebra I and geometry to graduate and then they've also got to have a third math credit. And so algebra I and geometry both are part of the state level. The core content is broken down into four different areas. And so those four areas is what we try to divvy out into the courses we teach. … [I also teach] Integrated Math II, which is a version of geometry. It's more of a hands-on approach to geometry.

HS went on to describe other nuanced differences between course titles and clienteles at her school. As suggested, Integrated Math (1-3) was the title of math courses for those not identified or reportedly interested in college preparation. These titles were under consideration for renaming as discussed elsewhere in this study:

> HS: … Now I did have a student or two last year ask me the difference between Integrated [Math] and the regular geometry. And, you know, I don't know whether they know or not, but I, like I said …I do think that those 8th grade [counselor] recommendations probably are kind of to push the college kids into the algebra I, algebra II and geometry. And the Integrated [Math sequence] is for the kids that are more headed towards a vocational program. But we don't want any kid in an integrated course to not be able to go to college. That's why we teach the same requirements. It's we teach the same core content. But, yeah, it's for kids that struggle a little bit.

LY, a science junior at RCHS became a key informant on a variety of issues at his school. He seemed to have pretty free range at RCHS, since he was judged both extremely bright and a good citizen. He described the course titles in math and the bifurcation of the curriculum at his school thusly:

> LY: … Well, in our school it seems as if math follows 2 varieties. You have accelerated math and normal math. And then you have several different math classes within each category. You have two algebras: beginner's algebra and more advanced algebra and geometry class, and there are several math electives like pre-calculus and calculus. And they don't have [two levels of] those. They consider those the accelerated classes in the more advanced study, as I suppose you would say. And, um, there is a grouping of about half and half . Half of the students take the more accelerated courses. Half of the students take the more generalized courses.

I found intriguing the idea that at both schools, the content of the advanced as well as the "normal" algebra and geometry classes was alleged to cover mostly the same material. Kentucky core content for math is the same for all students, so similar content was reported taught for all students for the three years of math that both schools required for graduation. LY explained it this way. So did most of the teachers.

> LY: Well, I talk to the teachers occasionally about what they do at the general courses because it's, just, it interests me to know where they are, where the courses are in relation to one another. And generally the relationship between the accelerated classes and the general courses is that the accelerated classes cover the same topics only they cover them faster and more in-depth. So, it's basically an issue of rigor. They make the accelerated students go through a bit more work and they make them do a bit harder topics. They make them learn a bit harder topics and the general students they learn the more fundamental things.

AM (the LCHS math department chair) also suggested that the nomenclature of classes undertaken at his school had as much to do with how the courses were perceived by colleges as it did with course substance, or with the sorts of ability grouping teachers were more comfortable with. Although the state core content standards did not specify tracking in math, the ability of educational institutions beyond high school to decipher higher and lower math achievers is pretty obvious in the passage below.

At LCHS, math requirements also had to total three years for high school graduation, but the courses were divided by semester. It seemed complicated to me, but here is the way AM explained the sequences and his hypotheses as to how they were designated. This passage clarifies a bit what HS suggested above:

> AM: …Use-to we had some classes called Basic Algebra and Basic Geometry, but our counselors found that was hard for students who took those classes and wanted to go to college. I don't think they were on their [the colleges'] list, or whatever there lists are—their numbering list. So [our counselors] added some courses—they are called Integrated Math—so our Integrated Math sequence would be basic algebra, and basic geometry and a basic algebra 2 sequence. It is not truly integrated like what integrated math really is. … Integrated Math 1 is like a Basic Algebra 1. It's the Algebra 1 content with not getting as in-depth with each topic. But it is generally the same topic. There's probably a few exceptions with a few topics, but generally the same topics. Integrated Math 2 is like a basic geometry, probably leaving out a few of the topics we do in geometry, and then Algebra 2 is similar to Integrated Math 3. That's what we have up to this point. Starting next year we are going to begin to phase that out. We are going to have every student taking Algebra 1; the only exception would be we are going to have an accelerated algebra group so we will have an Accelerated Algebra 1 with an Algebra 1. We will have Accelerated Geometry with regular Geometry, and students will have more flexibility in their scheduling that they can go back and forth if they get into accelerated classes and find that is more than they want to do: they can move. Right now, students start in Integrated Math 1 because of pre-college requirements they need to finish because, you know—if they want to go to college—if they take Integrated Math 1, they can't really jump to Algebra 2 because, when they get to that level, because of the sequencing.

Recapturing Eighth Grade Algebra

Taking ownership of school achievement meant that both teachers and administrators not only had to work hard in both schools and to devise innovations in how they presented material in class, but also, as suggested before, required them to revisit a previous tradition of facilitating introductory algebra in the Grade 8. In both of these districts, Grade 8 was part of middle school rather than high school. In both districts, however, high school teachers and administrators had come to believe by 2003 that if they were to be accountable for Kentucky core content performance in math, then all the relevant math instruction needed to be under their supervision. This was not the case in either school: the middle schools controlled what passed for algebra for some students, and middle school math core content either did not, or did not appear to, align with the algebra taught in the high schools.

Middle school staff I interviewed, however, argued that middle school academic standards were higher than those in the district high schools. Nevertheless, in both high schools of this study, efforts were under way to reassert authority over algebra. In previous years, college entry requirements appear to have led to better math students in middle schools taking some version of beginning algebra that was claimed to be equal to what was taught in the high schools at ninth grade. It appears parents played a role in encouraging this practice, in hopes of enabling particular children to get an extra year of math in the high school so as to enhance their advantage in the college-admission process. Teachers and administrators in both schools seemed to have mixed feelings on this matter. As advocates of math, teachers were happy to find students with great

interest who wanted more. But both of these rural schools had some difficulty justifying advanced math for only a handful of students, particularly at the smaller RCHS.

The principal at LCHS, well versed in the middle school curriculum from his earlier leadership duties there, articulated the gap between eighth grade Algebra 1 and what his high school teachers thought they needed to build upon in Algebra 2. The mismatch between the state core content and what Algebra teachers thought Algebra coursework should include is suggested in this passage:

> HA: I was formally the principal of the middle school and at one time we offered Algebra 1 there in 8th grade for credit. After the realignment of the curriculum of the middle school [to satisfy state requirements], their Algebra 1 was no longer an Algebra 1 class, so we're going back now and realigning so that [now we are] sending every [incoming] student into Algebra 1, whereas formally we had some students that were able to go to Algebra II coming out of 8th grade. Personally I prefer being able to offer Algebra 1 in 8th grade. I think it frees up an extra block in time for students here by getting one of the required subjects out of the way, but [our teachers] have other concerns that they're working on, so we'll adjust.

While staff at both high schools were wrestling with refusing to recognize eighth grade algebra as equivalent to what was taught in the ninth grade, high-achieving math students at smaller RCHS were happy to have more beginning math courses taught in the middle school, which in turn would potentially produce a larger population of students eligible for advanced math classes in the high school. LY perhaps did not realize that the 2003-2004 potential for AP (Advanced Placement) calculus at his school was perhaps only temporary, as the district was seriously considering not giving credit for middle school algebra in years ahead, just as was the case at LCHS. Here is how he was thinking of the sequence for accelerated students next year:

> LY: … we started that program where we're having eighth graders taking algebra, so it bumped all the courses down a year they were taking. Geometry is freshman. And Algebra 2 is sophomores. And then this year most of them are taking pre-calculus as juniors, myself included. Um, I've been asking around to see who all would take calculus courses—the calculus class. There'd be AP calculus or calculus. I'm not sure that there would be much of a difference, other than the fact that there would be an exam at the end of [AP]. But there are at least 20 people out

> of our class that are interested. And that's a fairly sizable percentage considering, I mean that that's enough for one class. In the past we haven't really even had enough for that.

This simmering controversy over access and excellence in math at both schools, further discussed in pages ahead, provided interesting differences of opinion. One of the Teacher Partners interviewed for this project was of the strong opinion that increased demand for math in Kentucky high schools would follow from instructional reforms like those championed by the NSF. Perhaps echoing the millennial teachers' dream, she was convinced that good math teaching would excite learners at LCHS, and that they would demand more math to whet their new-found appetites. Alternatively, I found to my surprise, that even the most talented math students at the other school in this study reported little intrinsic interest in math, even though they were good at it and saw its usefulness for their future lives. I asked the top ten math students who were taking pre-calculus at RCHS how many found math itself interesting and stimulating. Only two responded in the affirmative. Rather, they reported rather that in the peer group they identified with, advanced math seemed to be a requirement for being in the in-crowd. It was a sign or signal that they belonged in the college track. I found this "math is instrumental for peer group membership" of great interest. I am not sure that the math teachers at either school would be pleased; if accurate, this reason for taking advanced math for the bulk of students suggests such behavior has little to do with intrinsic affection for equations, proofs, and mathematical thinking!

Specifications of District Comprehensive Plans

The data and perceptions that have been presented thus far suggest interesting reform trends and convergences in some areas, but a few inconsistencies or counter-

intuitive dynamics in others. For example, it seems paradoxical that just as increased math is being encouraged and externally supported, state accountability interests within each building studied here force teachers to pull back from offering more advanced content. The Teacher Partner at LCHS assured me that math standards in Kentucky were heavily focused on the national standards (i.e., those of the National Council for the Teaching of Mathematics) in the beginning, unlike some content areas that were less nationally professionally driven; the Council's standards, in turn, call for more instruction in algebra in Grades 6- 8 (NCTM, 2000) . Abandoning formal algebra teaching in the eighth grade would on the surface, therefore, appear to suggest a retreat from quality, at least for some. It can be understood, however, as a response to the requirement imposed on Kentucky teachers that their students score well on the state accountability test; that test, after all, is driven by state core content, not directly by standards set by professional mathematicians like the National Council for the Teaching of Mathematics (NCTM). As schools continue to integrate their mathematics instruction in the years ahead, it seems likely they will seek to reconcile this apparent contradiction.

Other interesting potential alignment issues also exist between the academic programs and the career/technical/occupational programs in Kentucky. All Kentucky schools are required to create and adhere to a Comprehensive School Improvement Plan. These plans officially chart the road to meeting state accountability goals, step by step and objective by objective. Space does not permit reproducing the long and extensive school-wide Comprehensive Plans for each district, each of which was available on school web sites. The Comprehensive plan details particular and specific improvement

items and targets for each school and for each department. Table 3 does reproduce the math-specific plans articulated for RCHS, based upon state assessment data for 2001.

The flavor of targets and strategies for improvement for RCHS is suggested here; for LCHS the details are a bit different, but the concern and specificity are similar. In addition to the targets in Table 3, there are dates and teachers identified as well as funding sources for mandated aims. They have been left out of the table.

Table 3: RCHS Math Comprehensive Plan Items

Math:
• Teachers receive individual or shared professional development to meet content knowledge needs. (e.g. Algebra and Geometry For All Workshops—these workshops incorporate the use of technology, manipulatives, and a problem-solving approach to mathematics instruction as recommended by PIR and NCTM)
• Representatives of the department will attend regional, state, or national conferences. • *Share strategies with other department members.*
• PD credit will be given for teachers to outline instructional strategies most appropriate for Algebra I, Algebra II, and Geometry major topics.
• Algebra 1 will be restructured within the master schedule so that students taking it as freshmen will attend the course daily. The restructuring shall result in an additional 54 hours of class time for Algebra 1 students. • *Look at progress data for effectiveness (CTBS and beginning of year reports 03-04 from Geometry teachers).*
• Teachers teaching the same course will implement the same instructional strategies as outlined.
• At monthly meetings dept. members will report out on identified teaching methods, their application, and effectiveness. • *Continuation of strategies.*

It seems clear to this observer that school improvement and an ethos of school improvement runs high in both of the schools under review. The Comprehensive Plan(s) illustrated above gives specificity to their focus. So too does the testimony of the LCHS principal who reported intense work—often in conjunction with the several federally

funded teacher partners—that suggested how school Comprehensive Plans were practically implemented at his school. At both RCHS and LCHS, low-scoring students on the statewide CATS and CTBS tests were primary targets of improvement:

> HL: Well, we're doing a pretty intensive transition program, especially targeting some of the more at-risk students. And we've let the middle school staff help us identify those students. We have a week-long program in the summer, which is specifically for transition to help the students come in, help them be familiar with the building, learn some study skills, prepare for the class work that they're going to be seeing here and hopefully getting them off to a good solid start. This year we also had a special transition class that we offered first semester to a group of about 20 mostly at-risk students. Out of that group each taking 4 classes—so eight subjects—these were students the middle school told us would be the most likely to drop out, not succeed. So out of 80 classes there were only six F's. So we felt like that was very successful. In addition, by adjusting the curriculum we think we can help. One of the things we plan on trying in math this coming year is to split a class between algebra I and English I, and instead of the students being in there for only one semester, a 90-minute block, they'll be in the math class for 45 minutes every day all year long, and then they'll be in the English class 45 minutes. We feel like we can target some students there who may not be ready to take on so many concepts at one time, spread those out a little farther and give them a little more time to soak in.

The LCHS Math Teacher Partner likewise talked specifically about how her strategy to improve math scores and raise accountability scores, as discussed in their Comprehensive Plan, primarily by focusing on encouraging teachers to increase student performance of those in the lowest CATS category. In this passage, she talks again partly about the curricular alignment issues between the middle school and the high school at Lakeway County, and how she used empirical data as the starting point for making change proposals:

> BO: I started here after the 1st of the year. So when the January meeting [began] I had spent about a week messing around in their data, and in their January meeting we looked at data because the state does a pretty good job of dis-aggregation, but not what we needed to know. We knew that we had lots and lots of Novices, but the data I showed them showed that we weren't moving anybody that was a Novice in the eighth grade out of the Novice class in the high school. After we looked at the data we talked about several problems that we saw. We used an instrument that I got from using data and getting results to list several areas that we saw as problem areas, and then to rank order them to see what was at the top of the list. At the top of the list was Algebra I because they were having some, what it was, some kids come into the high school skipped Algebra I, having had it in the 8th grade, and went straight into Data and Measurement, but they weren't being as successful as we thought they ought to. [Meanwhile,] I went back and got all their kids' courses. If you came into Algebra I[in 9th ninth grade], you were going to score Apprentice. If you came in and took Integrated Math, which is their track, you'd be a Novice for sure. So I [asked,] what book are they using to teach Algebra I in the middle school, 'cause some of the kids were struggling more than they should. Well it turns out they weren't—they didn't have a book. Well if you don't have a book to teach Algebra I, that begins to open up a whole can

> of worms. So it turns out that they were certifying their best math students as being able to skip Algebra I, but you can't do that. It's a content question. They were baled, but not math prepared. So that was the big discussion at the leadership team meeting. That's how that kind of works. And that meeting went from 3 until 6, if that begins to tell you how that discussion rolled. The upshot is that all entering freshmen will take Algebra I next year at the high school. So that's the kind of change I'm interested in.

Two Dissenting Perspectives

The consistent stated aim in both high schools for targeting lower performing students to increase state accountability scores led to at least two interesting issues raised earlier in the literature review for this project. One dealt with concerns voiced clearly at one school that high-achieving, college oriented students were being shortchanged due to the focus on students perhaps previously overlooked in the schools. CP, a calculus teacher at RCHS, had two observations on ability and effort at his school. For all that is said and attempted, and for all the increases in math achievement, he still felt that math performance was not what it should be:

> CP: There appears to be, as far as what my perception is, much greater sense of apathy in the student population. We have a very good group of students here, I think, both in their behavior and they're a good group of high achieving students as well. But there does seem to be a greater sense of apathy then what I can remember as a student. … The school environment itself does not seem to, I don't want to say school environment, rather, student attitude does not seem to promote academics as a priority. It seems to be at most a second-place thing. It also kind of manifests itself in the amount of time devoted to the academics outside of school, as well as the core area of how much homework is returned in class. As such a lot of the students are not living up to their potential. There could be a lot of students that could achieve at a much higher level when they do.

In particular, CP believed that more academically proficient students were not being pushed in his school as they had been in the days when he had been among them:

> C: I think in the past teachers—probably when I was in high school here—I think that a lot of the students were, if I can quote, "being left behind" in that case. More of your—ah, I can't think of the word—more of your higher caliber students that were being pushed and were achieving [before], whereas a good chunk of the population, your middle chunk of the population, was being left out. And now that middle of the population is not being left out, yet it seems to be that we're now kind of teaching to the mean as well. Instead of the higher achievers being pushed up to that higher level of performance, they're left with the mean.

At the same time, in one of the schools in question there was direct competition between the technical/vocational programs with the more academic ones. And in the other school, there seemed to be a divergence of focus related to meeting immediate student and community needs versus preparation for the future.

As noted earlier in this paper, mid-twentieth century disputes about quality and importance were common between academic programs, curricula, and teachers and those in vocational subjects (e.g., Hollinshead, 1949; Peshkin, 1978). At RCHS, this debate continues in several forms. For example, the principal of the Career and Technical Center argues that his programs are just as rigorous and important as those in the academic programs of the high school. He also claims that programs at the Technical Center have a quicker payoff for students than some of the academic ones. He reasons as follows: The state of Kentucky, through the Workforce Development Cabinet, not the Department of Education, gives various sorts of certifications for achievement in his school; these certificates and concentrations in several fields enable regional employment right after high school; and established connections between Technical Center programs and several regional universities give college credits for many students' first college year. This is significant, he suggests, as higher education costs are still seen as prohibitive for many rural and poor students and their families.

There are four basic areas of concentration in the Technical Center, two of which some claim lead to jobs just as good as those available through the high school academic track and into college. He also argued the advantage of "hands-on" math for technical center students, even though the Business Math his school teaches does not count for high school graduation requirements:

> AL: Well, here at the _____ Career and Technical Center we have basically four programs. We have an industrial education program, which takes in welding and carpentry. We have an industrial technology program, which is an exploratory technology program [where] we kind of emphasize manufacturing skills. … We have a business education department. And we also have a health science program. As far as the type of math that we emphasize here at the tech center, it's probably more along the lines of applied math ah, and of course, in construction and industrial program we're talking about basic use of fractions and decimals and, you know, the use of calculators and simple division and multiplication and adding and subtracting, that type of thing. And students will be able to do that without the use of calculators. Ah, and again, for applied purposes. And the same thing holds true in the business programs and also [in] the health science program. Ah, but of course health science gets more into decimals and metric, that type of thing. But really we kind of emphasize the practical aspects and the applied application— how it is to be used. And, you know, that goes right along with the curriculum that we teach. We teach to the Kentucky Tech Curriculum. Anybody who wants to know the type of math we teach and where it's taught and how much can very simply go on the Kentucky Tech website, pull up the curriculum for the various classes that we teach, and they can actually see the tests that's taught in the math and so forth. Ah, you know, ah, and you know—according to the state, we're held accountable here in this school by our students scoring as well or better than the general population of the high school on the CATS assessments in the areas of math and reading and all the other content areas. We're also held accountable here at the technical school, as far as being the number of students who actually complete the Kentucky Skill Standards Assessment that the state department brought out about four years ago. And so in the last two years or three years since we've been doing this, I'm pleased to say that we've made it each year. And so ah, we have we have a good track record. We also offer to our students Kentucky Tech certifications of achievement. And that's in all areas except industrial education. We offer it in welding and carpentry, in the businesses, and also in health sciences. We offer the state certification based on the Kentucky Tech's curriculum. We also, in the area of welding, we take our students to Rowan Tech and have them take the state test, which encompasses a lot of math as well. And you know, they can get their state certification over there.

The Technical and Career Center at River County turns out to be an important player in the life of all high school students there, even though it is not under direct control of the high school principal. It is under the school board and superintendent, but its programs are sponsored and evaluated by several agencies. This leads to some tension between the high school and the technical center, as the Comprehensive Plan that drives school reform towards state accountability standards does not compel the technical center to coordinate their activities. Their teachers also do not participate in sanctions or rewards of the state assessments, although here (and in LCHS), there is some voluntary compliance and involvement.

AL argues that his institution is as important to the life of most students in River County as the high school. Of the 600 students in the school, most have taken one or more courses in the Technical Center, and as many as one third are "concentrators" who get certifications for future work or school there.

> AL: I think right now we have a little over 500 students. Yeah, a little over 500; maybe 505, or something like that, students right now. Last fall I think we had 475 that moved to the TEDS system. Ah, we've increased. As far as students taking classes here now that's [are] full-time equivalent students, that's how many different students are taking classes. … We don't have full-time credits. We don't offer, you know, the English and required classes. But you know if you divide a six-hour instructional day into the number of students and the number of hours that are here. Ah, we'd probably be something like 130 or 40 full-time equivalent.

AL, like generations of vocational teachers before him, seemed to wonder why "hands-on" and "manipulatives" were the rage in academic programs, and discussed a few of the barriers to his "hands-on" folks working with those in academic programs who were trying to make their classes more relevant in order to keep the attention of non-academically inclined students. He described the gulf between math and science teachers and programs in the two administratively different schools:

> AL: Now would it be better for the math teachers to come over and work with the industrial education people to, you know, to see how we're applying math so they could get a concept of how to apply math, how to make it more realistic in the classroom? Yeah, I'm sure. Would it be better for our industrial education people or our health science people to go over and talk with them to how they could relate what they're doing in their classrooms, the applied classrooms, to how they could better their academic math learnings? It probably would. I'm sure there's ideas that could be shared both ways there as far as ways we could improve enriching the math curriculum and ways that they can improve as far as finding practical applications and making it easier for students to understand. I'm sure it could be. Ah, but it's just difficult to do at this point in time.

In the meantime, several administrators in the county high school proper believed that the independence and competition from the technical center detracted from RCHS attempts to get more students focused upon academic programs and college-oriented math. One assistant principal argued that technical school programs should remain focused on those not intending to go to college, so that there would be greater demand for

more advanced math courses in the academic programs. As it was, he claimed, the technical center was drawing students he believed were college bound, much to their detriment. He also argued that the technical center played by different enrollment rules than did the high school, further heightening the attractiveness of technical programs to the detriment of those in science and math in his school:

> WT: [Technical Center programs] target kids that are going to college instead of kids that are going to vo-tech school, because they are driven by "completers," people that complete programs. And naturally, a kid that's college material, that's going to go to college is going to be somebody, that's going to stick with it. Kids that are going to go to a vocational school and have those type of jobs may not necessarily stick with it. So the [technical center is] not focused on going and getting those kids. Kids that we need to have over here taking AP chemistry and you know, AP biology and anatomy and physiology, to get the background to go into be a doctor to be a nurse, [instead] they're going into health sciences [in the tech center]. And it's not bad that they go into that, but I guarantee you when they go to college they're not going to have trouble with the nursing classes at the college, they're going to have trouble with biology 171, chemistry 111, chemistry 112. That's where they're going to wash out at. They're not going to wash out on the nursing classes, they're going to wash out on the science and the math. … but they go to the vocational school and I know why they do it. I don't think it's right. And if I was in [the technical school director's] position I would probably do the same thing he does. But, in my position I don't think it's right. Every year they turn away kids that should be in those vocational classes because they've got the kids that are going to college. I hate to say it, but a lot of our kids aren't going to go to a 4-year college like Morehead. They need this, not a lot, but there are several that need to go to a 2-year school to be a nurses aide or to be a LPN instead of an RN. And they need to have that background at the vocational school and they can't get in there because those classes are full, too. … They may say that they can't get over here, but all of their classes over there are capped. And they're capped at lower numbers than ours.

How Students View The Importance Of Math

Time for this study did not permit much examination at LCHS of the sort of vocational-academic rift found at RCHS. I did not sense this as a major problem in conversations with school administrators or teachers. At LCHS, however, the technical center was not on the same campus as the high school, and relationships between the administrators at both buildings was reported more congenial and collaborative. Even so, the LCHS Teacher Partner reported some tension:

> BO: I think there is some tension between those who see LCHS as a place to prepare students for post-secondary work and those that see it as a center of community involvement [but] I do agree … that there is little competition between the vocational and the academic folk.

There has already been some discussion of bifurcation within both of these high schools between accelerated, or academic, and general, "integrated," math programs. Actually, according to LY, there were three identifiable groups of students at his school, which may have been the case at LCHS too, although the availability of key informants there was more difficult. LY described his student body thusly as part of my interest in the vocational versus academic worlds that WT above made reference to:

> LY: Well, it's not really what subject they study. But it's more the difference of the groups that take the honors courses and the regular courses. There's generally two groups of students that take the regular courses. And there's only one group of students who take the accelerated courses. So you have a constant three group social order that we have, where one group dislikes school, one group is indifferent towards school and one group enjoys it, or at least enjoys it as much as we possibly can. And, generally, well those groups are sort of stiff toward one another. They don't—there isn't a heck of a lot of changing amongst them. … [The group that dislikes school] arrive as late as possible. They do not pay attention in class. They occasionally even sleep. And you always hear about their weekend exploits rather than what they did in school. And that's what you hear from them. The group that's fairly indifferent about school, the middle group, they—you hear about equal amount of talk from them from out-of-school talk and in-school talk. You would expect them to arrive on time. They're the 8:00 crowd, cause we take up at 8 now. And they, they view school as important but they don't think that it's the ultimate thing that shows their achievement yet. And then there's the third group that use school as most of what they do, and you can sort of tell it because they're the ones that are—well, they openly pay attention in class. And they're the ones that even go to the point to befriending the teachers and getting into conversations with them occasionally about the topics.

Even so, many students that LY might call the uninterested students have still acknowledged that high school completion is required in the 21st century—a major change since Trow (1959) wrote on this matter half a century before. Mark and Bill were both highly involved with technical school programs in Lakeway County, where they had been taking the bus from the high school to their technical center daily for some portion of their education for several years. Neither planned on going to college; but neither did either complain greatly about having to take math in the high school. Both were active in the electrician programs at the technical center, and both believed they had futures in the construction industry. One was already working for a local company part time. They

both believed that the teachers were concerned for their achievement, even if they would like to have had some changes. One quality of their rural math teachers, heard earlier in a different voice, involved a family and community connection to the chair of the LCHS math department outside of school. I asked them to comment on the quality of their math teachers. They responded:

> M: I've only had two different math teachers.
>
> AD: Were they both okay?
>
> M: Yeah, yeah.
>
> B: I had three different math teachers. They're all okay. Everybody says that one math teacher's like—he's got a farm right across from us, right across from ours. I mean I know most of them—like in one of the math teachers, she's married to my advisor and stuff.
>
> AD: So they're okay because you know who they are? … Because they are local people?
>
> B: Yeah.
>
> AD: So- anything you'd change about the math teaching here or the math teachers?
>
> M: Take it a little slower. That's what I'd change about it cause I think they move a little bit too fast for some people. I mean I can catch up to them sometimes pretty good real fast but some other people just don't get it. … if they got questions and stuff, I think it's just some people are scared to ask the questions that they need.
>
> AD: But they answer questions?
>
> B: Yeah. Usually if you ask them they'll answer about anything. They'll help you with any problems you have.
>
> AD: So you guys both gonna plan on both graduating, right?. Do you know anybody that doesn't graduate, doesn't plan to graduate from the high school?
>
> B: I don't know any, really. … Nowadays you need it. It's hard to survive now without even a high school diploma. You can't get a job in a factory without a high school diploma.

Other students with working-class aspirations also seemed to think that school was at least ok, and even desirable. They were more likely to report on the social benefits of schooling in an era when there are few alternatives for employment. Both of the young women in the following quotes found school to be a stabilizing influence for them while their parents and living situations seemed to change yearly. And they both

planned to leave the area after school completion since they did not even see minimum wage jobs in retail or restaurants emerging locally. These young women, who reported various difficult life experiences to date, had such things to say about school:

> HT: I love school. School's the best thing in the world. I don't care how old I am, I always want to stay in high school. You always got friends here. If you stay home all day long all you're ever going to see is the same four walls every day.
>
> RB: I don't know how people drop out of school 'cause if I didn't have school I would drive myself crazy sitting at my house all day. I mean even if I go somewhere, if I have a car and can actually go places, I'd miss school.

Each of these women had post-high school dreams that demanded some sort of additional education. Both unmarried, one had a new baby and hoped to enter a regional university that provided some day care for young children. She just wanted to have some experience as a free-spirited college student away from the control of her parents and now her boyfriend. The other young woman hoped to get some technical training to be able to work in Florida in video productions. Neither objected to mathematics, but both took "general" courses and plenty of subjects in the RC Career and Technical Center. They did know of former students who dropped out of high school; and they argued it was a big mistake:

> HT: I know a boy right now … He's in Garrison and he's going to be 18 next year and he quit here last year in his 10th grade year 'cause he was lazy; didn't want to do it. And he was always cussing teachers out and throwing fits. He's working in Cincinnati. He has to get up at 5 o'clock in the morning. Now he hates himself because he has to go to Cincinnati every morning at 5 o'clock and don't get home 'til 9 and only makes $100 a day. You know, he don't even make minimum wage. Cause $100/day for as many hours—that ain't minimum wage at all. And he's just mad and upset and he don't have money to go get his GED or anything. So he's just basically out in his own world, you know, he hates it.
>
> RB: He's stuck there.
>
> HT: That's the only advice I can give anyone that's coming around the school, especially the high school from middle school 'cause middle schoolers' minds change once they get here 'cause they're going to want to quit and get rid of it. That's my only advice—stay in school. Get it over with. Even if you make straight D's, go.
>
> RB: Can't get nowhere [unless] you want to stay in this town. Then you quit all you want. But, there's no way if you want to get out of this town and make something of yourself. You need to stay in school.

HT: Even if you make straight D's, you're still passing.

RB: Yeah, D's. I mean you can do better. It's not, you know, it's below average. But it's passing and as long as you get that high school diploma, then that's all you need.

Both of these students expressed satisfaction with their various math and science teachers, although they had had little experience with those whom the principal had described as the best in her school. The teachers they both seemed to like the best were in the technical center and taught applied subjects. One student reported early success in math; she also suggested she would have chosen accelerated math in her classes had she realized it was not much more difficult than general math. Interestingly, the exact names and titles of the courses these young women were taking or had taken at RCHS were unclear to them. They did not remember course titles well, but they did remember teachers. More specifically, they recalled teacher interaction "strategies" or behavior. Students started to report on several classes they were taking, detailing names and actions of teachers, but not about content. They seemingly could not fathom intrinsic interests in the subjects:

RB: No. I'm in _____. He's US History. And he just sits there and goes on about history. I ain't worried about it.

HT: I think Mr._____ and Mr. _____ are like— they got something wrong with them. They're like "into" US History. I mean, they're big fans of it.

RB: If you wouldn't— yeah, I think they would teach US History even if you weren't paying them. I mean they're just all into it. They get excited about it. They'll jump up and down excited about it. That's what I like about Mr. _____ 'cause he's lively. He talks really loud and you can't fall asleep in the class 'cause he talks so loud and he's always like clapping his hands, doing something.

HT: Mr. _____'s always running in circles around our desks. You know, when he comes to talk to you he'll look straight at you and you'll be like talking to him, and all of a sudden he'll look the other direction and start talking to someone, nodding his head. He's always doing this. He's always up running in a big circle.

RB: Ms. _____, she's in vocational, she teaches health sciences classes. I think it's Health Science 1 & 2 she teaches. And she's, oh my gawd, she's more lively then Mr. _____. She'll just, I mean, she'll teach you like—when we're taking notes, and if no one says anything she just

> start screaming and jumping up and down, I mean, she's so lively. I mean, she just, she's happy all the time. She loves teaching health science classes. And I think you, if someone actually says "we can't pay you no more," she'd teach it anyways. That's how she was. She just gets into it.

Some teachers and other students, though, seemed to be wary of the idea that just sticking with school and finishing the basics was the key to some sort of success. Moreover, as the RCHS calculus teacher said, that this idea also applied to too much thinking among "better" students, as previously suggested. Rather then taking more challenging or elective courses, he opined, many students at his school had somehow come to believe that completing their minimal math requirements in high school was some sort of guarantee of success in college and later life. He thought this was a wrong message they were receiving from somewhere, and his science department was trying to find out where. In the meantime, he hypothesized:

> CP: I think it [partly] goes back to the apathy, the students don't really have the drive to take those elective courses. … For instance, … [a] junior was planning on going into pharmacy after he graduated, so he was going to presumably take a chemistry major and work on going to the pharmacy school. His question was, "should I take a physics class or a calculus class or should I just wait until I go to college until I take those?" Because his presumption was that the physics and the calculus course that we offered here was exactly like what the college course would be, and they're, you know, they're not in that extent. And they don't view the courses they take here as a preparation for further education at a later time. As such they don't see a real use for the courses. They don't see the value.
>
> AD: And why don't they? Why wouldn't they know that
>
> CP: Well, I think that probably, if I'm going to make a hypothesis, I'm going to say that that's probably due to the social climate … in the community. We have a large percentage of our population in this area that are not college educated. I mean, many of them have never taken any college courses in their lives, nor have they ever set foot on a college campus. They simply don't know what such endeavor entails. As such, when they try to advise their children or their neighbors or whomever they come in contact with, their advice may be "well, you don't need that," or "you can take that in college," or so on, and they don't understand the preparation that's required to achieve and be successful in that post-secondary education. That would be my hypothesis at least. … There are [also] some misconceptions. For instance, I'll ask a lot of my students "well, what are you planning on going into when you leave here?" I will have a disproportionate number who are going to be engineers, doctors, lawyers and so on. And while it's not bad to have high expectations and high hopes, the bottom line is there is a small population that can go into those fields, and it is a rigorous pursuit and they have to have an adequate preparation to do so. Now why do they think that they're going to do that while they may not be taking—they might be saying, "Well I'm going to be an engineer, I don't need math. I'm not going to ever use that, I'm going to be an engineer." Well, one; they don't really understand what the field entails; two again, they [overestimate] the value of the courses they're taking, and then

> also three: they may have gotten good grades, they may be a good student. Well, the parents may not have had a good experience with their school growing up. They may not have gotten good grades. Well, maybe yesterday Johnny is coming home with A's an B's and parents say "well you're brilliant! I could never get A's and B's in school. You can be a doctor, you can be a lawyer, you can be an engineer, you can be anything you want to be." And, again, I'm not saying to crush any hopes whatsoever, it would please me nothing more then every single student that left here to do that, but in practicality, that simply doesn't happen, and there has to be the adequate preparation to be able to achieve those goals and as such, I think there's a lack of experience with some of those higher professions, if you want to call them that and with the higher education. And without that experience the population simply does not know what is required to get them there.

CP then also argued that GPA and college costs were factors in minimizing the choices for advanced math that many students at his school were taking. Unlike concerns at the larger LCHS (with 800 plus students), low enrollments for advanced math meant there that such courses were rarely available at RCHS (with a total enrollment of about 600), as LY reported as well. Within the school, there was also great reported interest in being identified as the class Valedictorian or Salutatorian. GPAS, as usual, were the primary markers for this event. However, CP and others reported, few high-achieving students would take a challenging course if it threatened their GPA. This would knock them out of consideration for class prestige. And, RCHS had few weighted AP courses that could compensate for obtaining a "B" in a difficult class. Further complicating the process was a state higher education tuition subsidy based also upon GPA. Each of these "structural" factors was voiced as causes for less academic "risk taking" at RCHS, although I did not hear of such things at LCHS.

CP again:

> Further, we have a large percentage of our students compared to previous that go onto a higher education, to a college environment, after they graduate here. As such, parents are rightfully concerned about grade point averages, and sometimes the trade-off between taking the more rigorous course and taking a non-rigorous course, however you want to look at it—one that is not as high of rigor—is that the grade point averages do not remain at the same level. They tend to drop a little bit with the more rigorous course you take. And the parents are usually not willing to see that trade-off because GPA's relate directly to scholarships and other funding and money is a concern. We are in a low socioeconomic spectrum here. … [Scholarship] money is a concern because as part of the calculation, GPA's are figured in. There is also an ACT component, I believe if I'm thinking correctly, and my argument has been, just in terms of money, that while their GPA's may drop by a fraction of a point, their ACTs may go up enough to compensate in

> that case. But that's more of a practical argument, and it's dodging the main point to begin with I think, to just put a patch on the problem. So, I'm not so sure that I think [the scholarship program is] a good program. I think there are probably students who, due to it, are probably going to be able to go to college that couldn't otherwise. However, I think there has to be a balance in there somewhere to keep [good students] taking the rigorous courses because what good is the money going to do them for a semester if they can't stay there once they get there, if they flunk out after that. At least that's my personal viewpoint.

The observations above were also sounded by the science Teacher Partner at RCHS. She also complained of students confusing "seat time" with learning, and worried at her school that vocational courses created some important problems for a rural high school that wanted to increase math achievement for potential college goers. Echoing CP, JS had these several things to say about vocational subjects, as well as science and math issues, in her school:

> JS: We have a really good vocational school. There are excellent teachers in it. Great opportunities for the kids. We just think they target the wrong students. Many of our better students are enrolled in those classes. They don't take, [but] we can't get calculus to make most of the time [or] Chemistry II, physics II, those kinds of classes, because they're enrolled in vocational classes, and they are under the assumption that they really need these vocational classes, and that these certifications are going to be real important. When you have kids who are going into medicine or engineering or pharmacy or computer sciences to be programmers and that sort of thing, they need upper level courses. They don't need to be vocational courses. Prime example is we're battling them over weighted grades. We want to weight AP grades so we can get some upper level classes back. We did away with weighted grades several years ago because of the consolidation issue with _____High School, and they didn't have equivalent courses. … So to make everything equal we did away with that. We had a big battle trying to put it back in place. Our battle's with the vocational school. They want to weight their classes and it doesn't make any sense. The weighted grades are for those kids who are vying for scholarships and in fact for KEYS money they will automatically waive AP grades for KEYS money. And they have done a really good job convincing these kids that these certifications are going to matter when they get to college, and so the kids going into some of these careers are not going to matter. We have kids take three years of health science over there—health sciences—and not take the chemistry and the physics and the other courses that they need because of that. And I think it's probably good for some of them, especially if they're going into nursing to get their feet wet in the health sciences program. Kids going on to medical school—they're shooting themselves in the foot. In fact, they're not being successful when they go to college 'cause they're not taking those classes. We can look back at the kids who did take physics, who did take chemistry II, they've stayed in their major, they've made good grades, they've been successful 'cause they have the background to do it. And the kids who haven't are struggling.

Some Concluding Observations

Who is the math teacher and what is mathematics in rural Appalachian high schools? That is the question addressed by this study; a few observations can now be made. The usual limitations, of course, remain in place: this study was of two particular schools, volunteering to participate, networked with several major national professional development initiatives, and within a state already vigorously moving ahead in various accountability dimensions. These schools may or may not be typical of the larger population of rural schools in general or rural Appalachian schools in particular. On the other hand, many of the issues and concerns of mathematics programs and teachers found here are reflected in earlier and more contemporary scholarly discussions of rural American education. A final limitation of this study was that of time and depth. More community voices should have been heard here; and more from other teachers in the school in arts and humanities subjects. Neither time nor resources permitted the inclusion in this iteration. In any event, I conclude this writing with some general observations of themes I believe could and can be found in the schools investigated. I try not to move too far beyond the data here; locations for discussion and debate are also to be found in previous narrative sections of this study.

Math Teachers Are Highly Prized

In both the schools of this study, school accountability concerns ran high. Both schools had some history of success at achieving state-mandated goals. And both schools could point to their mathematics scores and to their mathematics teachers as partly responsible for success. I found no disparaging comments about math teachers at either

school, while there were many complimentary ones. Administrators and fellow teachers were happy to have a solid math focus in their schools, and these teachers were recognized for their efforts.

At the same time, pressures for increased math outcomes on CATS tests were spelled out in Comprehensive Plans at both schools, and math teachers were expected to respond. The fact that math teachers had external linkages and help was seen as a positive by administrators, and since school-wide improvement was important to all staff, these connections related to outcomes seemed a plus for most of the staff interviewed.

Students, meanwhile, mostly reported positive feelings for their math teachers; some felt compassion for them in their struggle to work with "general" students as well as those more (math) achievement oriented. Some felt that higher level teaching, courses, or both were desirable, but few thought it was the teachers' fault that these levels could not be attained. Teachers were doing their best to reach all students. This latter finding, albeit from a smaller sample of students than I had hoped for, surprised me. I had expected to hear less "motivated" students complain of teacher indifference, but most attributed lack of math achievement (if any) to their own lack of interest, not to teacher enthusiasm.

Math Teachers Are Working Hard To Improve

The ethos of math teachers in this project was very much improvement oriented. In both schools, math was understood as an innovative and hard-working department. School administrators at the central office and building levels were also keenly aware and involved in spurring math teachers forward to enhance accountability concerns. Teachers

at both schools expressed interest in some or most NSF activities, although this enthusiasm was suggested by administrators to vary somewhat between individual teachers.

Math Teachers Are Hard To Replace

Sparsity and scarcity have been oft-repeated themes in the rural education literature. Driven by per-pupil funding formulas, school districts with declining populations have historically been challenged by a lack of resources and difficulty obtaining specialized teachers. KERA in Kentucky for the moment, at least, has addressed the first of these difficulties. Throughout the 1990s, extra monies for poor districts buoyed local schooling efforts. On the other hand, the announced national shortage of math and science teachers seems particularly acute in rural Appalachia—the improvement of which is of course the explicit aim of the various NSF projects previously mentioned. In both LCHS and RCHS, much reported energy and effort by the central office either was or is being dedicated to finding, recruiting, or training adequate math teachers. Principals at both schools in this study essentially argued that they had dodged bullets in being able to find people they wanted for the jobs they had. And they were major supporters of NSF efforts to help them improve teachers and train new ones.

Math Teachers: Abstract vs. Hands On?

The century-long (if not longer) debate about whether the aim of secondary education is to help its graduates escape local communities via academics or to instill in them a vocational and technical education of locally useful skills remains in both of the counties studied here. Details differ between the sites. In the current environment,

however, post-secondary education is understood as important for either type of future; the tension in these rural high schools was about what sort of past-secondary education would be undertaken, not over whether it would be a good idea. This is an important transformation. Therefore, much of what I seemed to hear about math in both LCHS and RCHS was focused upon changing the image of math from an abstract and distant subject to one useful and immediate for either future. This was not a novel concept, although there was a new immediacy to this concern driven partly by state accountability mandates. The language of immediacy does seem to have changed, however; where teachers once simply referred to "hands-on" activities, they now talked of the concept of "manipulatives." The "hands-on" approach seems to have become more dominant in American high schools, if experiences at LCHS and RCHS are any guide. The announced goal of math teachers is now to target kids in the middle and at the lower ranges of interest. ability, or achievement for the post-secondary options that might await them. Very few math teachers or administrators I talked with excitedly championed the teaching of theorems or laws or proofs. Not that these things are not taught; rather, my guess is that such talk might be understood as off-putting to many students.

Math in these two high schools seems now repackaged as "user-friendly" curricula, and the users are to be the bulk of students, not just the future mathematicians. The concerns mentioned earlier by Martin Trow, that somehow American high schools would have to change their cultures to create a mass-preparatory experience, appears to have happened in at least these two schools. Most students believe that math is at least tolerable, and at worst, kids can get it over with, as HT argued earlier. Nevertheless,

there are those in both LCHS and RCHS, both teachers and students, who seem to miss days when math was seemingly esoteric and mystical.

Qualitative work is rarely undertaken in order to demonstrate "results." This study found differences and similarities between the schools under study and national discussions of rural American education. What these findings mean is open to further interpretation. Do the previous pages misrepresent the "real" facts? Are they characteristic of these schools only, with little to offer in the way of understanding rural high schools in general? Whatever answer the reader may offer, such concerns remain worthy of further discussion, debate, and study.

References

Atkinson, Paul, 1990. The Ethnographic Imagination. London: Routledge.

Bestor, A.E., 1953. Educational Wastelands. Urbana: University of Illinois Press

Bickel, Robert. 1989. Post-high school opportunities and high school completion rates in an Appalachian state. *Youth and Society* 21(1): 61-84.

Bogdan, Robert and Sari Biklin. 1998. Qualitative Research in Education (3rd. edition). Boston: Allyn and Bacon.

Brint, Steven.1998. Schools and Societies. Thousand Oaks, CA: Pine Forge Publishers.

Collins, Randall. The Credential Society. New York: Academic Press.

Conant, James, 1959. The American High School Today. New York: McGraw Hill.

DeYoung, Alan J. 1995. Life and Death of a Rural American High School. New York: Garland Publishers.

DeYoung, Alan J. 1991. Struggling with Their Histories. Norwood, NJ: Ablex Publishers.

DeYoung, Alan and Craig Howley, 1990. The political economy of rural school consolidation. Peabody Journal of Education, 67(4): 63-89.

DeYoung, A.J. and Lawrence, B., (1995). On Hoosiers, Yankees and mountaineers. Phi Delta Kappan. 77(2): 104-112.

Dewey, John (1899). The School and Society. Chicago: Univ. of Chicago Press.

Eller, Ronald, 1982. Miners, Millhands, and Mountaineers. Knoxville: University of Tennessee Press.

Fuller, Wayne, 1983. The Old Country School. Chicago: University of Chicago Press.

Geertz, Clifford, 1983. Local Knowledge. New York: Basic Books.

Gjelten, Tom (1982). A Typology of Rural School Settings. Washington, DC: U.S. Department of Education.

Hare, Dwight, 1991. Identifying, Recruiting, Selecting, Inducting and Supervising Rural Teachers. In Alan J. DeYoung (ed), Rural Education: Issues and Practice. New York: Garland: pp 149-176.

Hartford, Ellis, 1977. The Little White Schoolhouse. Lexington, KY: University of Kentucky Press.

Herzog, Mary Jean and Robert Pittman, 1995. Home, family and community: Ingredients in the rural education equation. Phi Delta Kappan: 77(2): pp 113-118.

Hollingshead, August (1949). Elmtown's Youth. New York: John Wiley & Sons, Inc.

Horn Jerry, 1985. Recruitment and Preparation of Quallity Teachers for Rural Schools. Washington, DC: US DoE.

Kliebard, Herbert, 1986. The Struggle for the American Curriculum, 1893-1958. London: Routledge and Kegan Paul.

LeTrende, G., Hofer, B. and Shimizu, H. 2003. What is tracking? Cultural expectations in the United States, German, and Japan. American Educational Research Journal: Vol. 40 (1), pp. 43-89.

Merriam, Sharan. 1998 Qualitative Research and Case Study Applications in Education. San Francisco: Jossey-Bass.

Monk, David. 1991. The organization and reorganization of small rural schools. In Alan J. DeYoung (ed): Rural Education: Issues and Practice. Op cit.:177-201.

National Council of Teachers of Mathematics. (2000). Principles and Standards for School Mathematics. Reston, Va., NCTM, 2000. Retrieved November 8, 2003 from http://standards.nctm.org/document/chapter3/alg.htm .

Oakes, Jeannie. 1985. Keeping Track: How Schools Structure Inequality. New Haven CT: Yale University Press.

Opler, Morris, 1945. Themes as dynamic forces in culture. American Journal of Sociology, 53: 198-206.

Perkinson, Henry. 1995. The Imperfect Panacea (4th edition). New York: McGraw Hill.

Peshkin, Alan, 1978. Growing Up American. Chicago: University of Chicago Press.

Spradley, James, 1979. The Ethnographic Interview. New York: Holt, Rinehart and Winston.

Spradley, James and Davic McCurdey, 1972. The Cultural Experience: Ethnography in Complex Society. Chicago: Science Research Associates.

Spring, Joel 2002. American Education (10th edition). New York: McGraw-Hill.

Trow, Martin (1961). The second transformation of American secondary education. International Journal of Comparative Sociology. 2: 144-165.

Tyack, David (1974). The One Best System. Cambridge: Harvard University Press.

Whisnant, David, 1980. Modernizing the Mountaineer. Boone NC: Appalachian Consortium Press.

Woods, Peter. 1983. Sociology and the School: An Interactionist Viewpoint. London: Routledge and Kegan Paul.