MATHEMATICS COURSE-TAKING IN RURAL HIGH SCHOOLS

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Using data from the 2005 NAEP High School Transcript Study, this paper examines the mathematics course-taking of rural high school students. Although several studies indicate rural high school students' mathematics achievement is comparable to that of students in non-rural high schools, the mathematics course-taking patterns of rural and non-rural high school graduates are not the same. The data suggest that, regardless of location, high school graduates typically earn more mathematics credits than that required for a standard diploma; however, graduates of rural high schools generally earn fewer mathematics credits than graduates from other locations. The data also suggest that, when compared to students from other locations, rural high school students tend to begin high school at a slightly lower level of mathematics and end their mathematics studies sooner, thus achieving an overall lower course-level of mathematics. Graduates from rural high schools also appear to have had substantially less access to AP mathematics courses.

Mathematics educators and education researchers have an ongoing concern with students' achievement and participation in mathematics courses. Many argue that mathematical knowledge is necessary for *all* individuals since economic, social, and political opportunities depend on it (e.g., D'Ambrosio, 1990; Moses & Cobb, 2001; National Council of Teachers of Mathematics, 2000). Yet, it is recognized that all groups of students do not have comparable access to mathematical opportunities, success in mathematics courses, or motivation for continued study of mathematics. The mathematics achievement and participation of several groups of students have received attention in the research literature. For example, studies have analyzed data from U.S. students grouped by race, ethnicity, gender, and socioeconomic status (Davenport, et al., 1998; Ingels & Dalton, 2008; Lubienski, McGraw, & Strutchens, 2007; Strutchens, Lubienski, McGraw, & Westbrook, 2007). Another significant, but often overlooked, group is the nearly 10 million students attending schools in rural areas and small towns. This group consists of approximately one-fifth of U.S. school-age children (Johnson & Strange, 2007).

Across high schools, students in rural areas often have experiences different from those in non-rural areas since rural schools are typically smaller in size (Beeson & Strange, 2003), less likely to offer advanced coursework (Greenberg & Teixeira, 1998), and often farther from colleges or universities (Gibbs, 1998). Since it is a sizable group of students, it is worthwhile to track the mathematics achievement and participation of students in rural areas to determine if they have access to and achievement in mathematics comparable to their non-rural counterparts.

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Purpose of the Study

The purpose of this study was to investigate differences in mathematics course-taking among students in rural and non-rural locations. We report on data collected as part of the 2005 High School Transcript Study (HSTS; Shettle, et al., 2008). Specifically, the following questions guided our investigation:

- Does the number of mathematics credits earned by high school students differ by school location? If so, which group of students earns more mathematics credits?
- Do mathematics course-taking patterns differ for high school students by location? Do students from different locations begin their high school mathematical studies in the same course? Do they finish in the same course? In which grade do students terminate their mathematics studies?
- Does access to advanced mathematics classes (i.e., Calculus, AP Statistics) differ by school location?

In the next section we provide background on the mathematics achievement and participation of students in U.S. high schools. Then, we describe the data collection and methodology. Following that, we present the results of the analyses to answer the research questions. We conclude with a discussion of the results, point out limitations of the study, and suggest questions for investigation.

Background

Several studies provide an indication of the scope of rural high school students' mathematics education. Other studies provide a look at mathematics course-taking and course offerings for students without respect to location. Howley and Gunn (2003) survey the literature on the mathematics achievement of students in rural schools and conclude that the mathematics achievement of students in rural areas is not below that of students in non-rural areas. Historically, educational attainment has been lower than average for residents of rural areas. As educational attainment has increased over the past several decades, achievement has increased as well. Data from the National Assessment of Education Progress (NAEP) show that mean mathematics achievement differences between rural and urban 17-year olds have not been significantly different since 1988 (Greenberg & Teixeira, 1998). Fan and Chen (1999) report that the National Education Longitudinal Study of 1988 also indicates students in rural areas are not disadvantaged by their education in rural schools. Specifically, students in rural areas performed as well as students in non-rural areas on a standardized mathematics achievement test. Additionally, 1996 NAEP data reveal rural students outperformed non-rural students in eighth grade mathematics (Lee & McIntire, 2000). Yet, it is recognized that mathematics achievement among students in rural areas is varied. Lee and McIntire point out that improvement in mathematics achievement scores varies by state. In 21 of the 35 states included in their study, there was no difference in mathematics achievement between rural and non-rural students. In seven states, rural students outperform non-rural students in mathematics while in another seven states rural students' mathematics achievement scores lag behind their non-rural counterparts. The demographic makeup of the student population may explain some of this variation (Johnson & Strange, 2007).

National achievement studies such as NAEP are one indicator of students' mathematics education across rural and non-rural schools. However, these large-scale studies focus on the mathematics learned in introductory high school coursework and do not go beyond "the rudiments of algebra and geometry" (Kilpatrick & Gieger, 2000, p. 378) to consider course-taking or participation in advanced mathematics courses (e.g., Pre-Calculus, Calculus), the focus of this study. Based on data from the HSTS, we consider whether high school graduates' course-taking and participation in mathematics courses differ in rural and non-rural schools. Related to participation, we also consider opportunities in advanced mathematics courses as an indicator of the mathematics education available to students across locations. A literature review reveals some studies focused specifically on mathematics course offerings available to rural high school students while others focused on the offerings by school size. Since rural high schools are often smaller than high schools in non-rural areas (Beeson & Strange, 2003), both types of studies give us an indication of differences in mathematics course offerings across high schools. Barker (1985), Monk and Haller (1993), and Robinson (2003) all found that high schools with smaller enrollments are more likely to have fewer course offerings. Barker's national survey showed that differences in offerings of Advanced Geometry, Calculus, and Probability/Statistics were statistically significant between small schools and large schools. For example, Calculus was offered in 55.6% of small schools, compared to 90.2% of large schools. Similarly, Greenberg and Teixeira (1998) report that 64.2% of rural 12th-grade students were enrolled in schools that offered Calculus, while 93.2% of urban students' schools offered Calculus. Haller, Monk, and Tien (1993) also found that rural schools have fewer advanced mathematics course offerings than non-rural schools. Their analysis suggests, however, that more narrow offerings in rural schools do not have a negative effect on students' mathematics achievement. Overall, the literature supports the idea that students in rural high schools have fewer mathematics course options, particularly in advanced mathematics, than do students in non-rural high schools. This indicates the potential for an opportunity gap for rural and non-rural students wishing to study advanced mathematics in high school.

Although the research literature on rural students' access to and participation in mathematics courses is less current than the literature on rural students' mathematics achievement, recent studies do provide a picture of students' mathematics course-taking in general. Over the course of the last quarter century, high school graduates have tended to enroll in an increasing number of mathematics courses (Planty, Provasnik, & Daniel, 2007). For example, about one-fourth of high school graduates completed a mathematics course more challenging than Algebra II in 1982, but this rose to half of high schools graduates in 2004. Similarly, just less than one-half of graduates completed Geometry in 1982 whereas just over three-fourths of graduates completed Geometry in 2004. Enrollment in Calculus courses has also increased, more than doubling from 6% of graduates in 1982 to 14% in 2004. More seniors were taking Calculus than any other mathematics course in 2004 (Ingels & Dalton, 2008). These findings do not indicate whether all students, regardless of school location, have similar access to the courses.

At present, students take more high school mathematics

Table 1
Location Descriptions

Central City	The Central City category includes central cities of all metropolitan statistical areas (MSAs). Central City is a geographical term and is not synonymous with "inner city."
Urban Fringe/Large Town	Urban Fringe includes all densely settled places and areas within MSAs that are classified as urban by the Bureau of the Census. Large Towns are defined as places outside MSAs with populations greater than or equal to 25,000.
Rural/Small Town	Rural includes all places and areas with a population of less than 2,500 that are classified as rural by the Bureau of the Census. Small Towns are defined as places outside MSAs with populations of less than 25,000 but greater than or equal to 2,500.

Source: NAEP Data Explorer Advanced Help. http://nces.ed.gov/nationsreportcard/nde/help/adv/.

courses than in the past, but there remains a gap in mathematics participation among subgroups of students. Differences in high school mathematics course enrollment between male and female students have diminished over the years and are small or nonexistent (Boaler, 2002; Davenport, et al., 1998; Ingels & Dalton, 2008). There remain, however, differences among students grouped by race/ethnicity and socioeconomic status. Black and Hispanic students enroll in advanced mathematics courses at lower rates than White or Asian students. In 2004, the rate Asian students enrolled in advanced mathematics courses was three times that of Black or Hispanic students; White students enrolled at a rate twice that of Black or Hispanic students (Ingels & Dalton, 2008). We recognize that the rural population is not homogeneous, and that gender, race/ethnicity, and socioeconomic status impact students' mathematics education (Fan & Chen, 1999; Flores, 2007; Kilpatrick & Geiger, 2000).

Methodology

The NAEP HSTS, overseen by the National Center for Education Statistics (NCES), was created in response to a need for more in-depth data about students' educational progress and achievements (Shettle, et al., 2008). Since 1982, HSTS has been conducted every three to four years to provide information such as student course-taking patterns and summary high school achievement indicators such as Grade Point Average (GPA). Complete technical details of the study are available in Shettle, et al.

The data set discussed in this paper was collected in 2005 and drawn from a stratified random sample of schools from across the nation. The data consist of complete transcripts, including courses taken and grades earned, from over 26,000 high school seniors sampled from approximately 2.7 million students who had graduated from high school by October 2005. "Graduates were defined as persons receiving a special education, regular education, or honors diploma" (Shettle et al., 2008, p. 9). Students from both public and private high schools were included. Statistical analyses were conducted using the NAEP Data Explorer[1], a publically accessible online data analysis tool.

Data collection and coding were conducted by Westat, a research consulting firm, under the supervision of NCES. Field workers gathered transcript information including course catalogs from each high school identified for the sample. Each course was coded using the Classification of Secondary School Courses (see Shettle, et al., 2008). Similar courses are grouped under stubs such as Basic Math, Pre-Algebra, Algebra 1, Geometry, etc. in the classification listing. Each stub was expanded to include more specific course titles. For example, Plane Geometry, Solid Geometry, and Informal Geometry were all coded separately within the Geometry stub. Students' schools were coded with a *location* variable with one of three mutually exclusive descriptors based on population: Rural/Small Town, Urban Fringe/Large Town, and Central City (see Table 1). For simplicity, we refer to the three descriptors as Rural, Urban Fringe, and Central City, respectively. We acknowledge this designation, although convenient, does not capture the economic and social diversity of rural places as recognized by other scholars (e.g., Brown & Swanson, 2003). The HSTS data revealed that approximately 28% of 2005 high school graduates graduated from rural high schools, 46% from Urban Fringe high schools, and 27% from Central City high schools. Unfortunately, the NAEP Data Explorer did not reveal the sample size of each subgroup in the overall sample.

[1]The NAEP Data Explorer is available at http://nces.ed.gov/nationsreportcard/hstsnde/. The advanced help can be accessed at http://nces.ed.gov/nationsreportcard/nde/help/adv/.

Table 2

Percentage of Students by Number of Mathematics Credits and Location

Location	Number of Credits Required			Number of Credits Earned			
	≤2.0	2.1-3.0	≥3.1	≤3.0	3.1-3.5	3.6-4.0	≥4.1
Rural	28 (3.1)	53‡ (4.7)	19†(3.7)	35* (1.6)	8 (1.0)	34 (1.6)	23 (1.7)
Urban Fringe	22† (3.1)	67 (3.8)	11 (2.2)	29 (1.1)	8 (0.8)	37 (1.6)	26 (1.06)
Central City	33 (4.5)	58 (5.2)	9 (2.3)	29 (1.8)	9 (0.9)	36 (1.8)	26 (2.1)

Note. The standard errors of the statistics appear in parentheses. Percentages omit missing data.

*Significantly different from other locations at $p < 0.05$.

†Significantly different from Central City at $p < 0.05$.

‡Signficantly different from Urban Fringe at $p < 0.05$.

Results

Mathematics Credits

Does the number of mathematics credits earned by high school students differ by school location? Table 2 shows the percentage of students in each location (Central City, Urban Fringe, Rural) with the number of mathematics credits *required* for a standard diploma and the number of mathematics credits *earned* by graduates. The distribution of credits required for students in the three locations indicates that approximately two-thirds of students in Urban Fringe high schools were required to take 2.1 to 3.0 mathematics credits. This was higher than the percentage of students required to take 2.1 to 3.0 mathematics credits in either Central City high schools (not statistically significant difference) or Rural high schools (significant $p < 0.05$). The residual of Rural high school graduates is distributed differently from that of graduates from Central City high schools. On one hand, a higher percentage of students in Central City high schools were required to take up to 2.0 mathematics credits for a standard diploma. On the other hand, a larger percentage of students in Rural high schools were required to take more than 3.0 mathematics credits. In other words, a larger percentage of Rural high school students (19%) were required to take more than 3.0 mathematics credits than either students in Urban Fringe high schools (11%) or Central City high schools (9%). At the same time, the percentage of Rural high school students (28%) required to take 2.0 or fewer mathematics credits was lower than the percentage in Urban Fringe high schools (22%), but lower than Central City high schools (33%). Thus, using 2.0 mathematics credits as a point of reference, the percentage of Rural high school students exceeding 2.0 mathematics credits was higher than the percentage of Central City high school students, but lower than that for Urban Fringe high school students.

Overall, high school graduates were taking more mathematics credits than required for a standard diploma. Nineteen percent of Rural high school students were required to take more than 3.0 mathematics credits, yet 65% of Rural high school students earned more than 3.0 mathematics credits. A similar trend held for students in Urban Fringe and Central City high schools with 71% of those students earning more than 3.0 mathematics credits. More than half of all students in each location earned more than 3.6 mathematics credits meaning they were, in effect, earning credit for four years of high school mathematics courses. Approximately one in four students, regardless of location, earned more than 4.0 mathematics credits. The distribution of the percentage of students earning credits was essentially the same for students in Urban Fringe high schools and Central City high schools. The distribution of students in Rural high schools was shifted toward fewer credits. Although not statistically significant, the percentage of Rural high school students earning 3.6 to 4.0 (34%) or more than 4.0 credits (23%) was less than the percentage of students in either of the other two locations. Rural high school graduates (35%) were more likely to earn 3.0 or fewer credits than graduates from Urban Fringe high schools (29%) or Central City high schools (29%). This difference is statistically significant at $p < 0.05$, but may not have practical significance although taken from a large sample ($n \approx 26{,}000$).

Mathematics Course-Taking

We now consider the mathematics courses students completed while in high school. In which mathematics courses did students enroll when beginning high school in Grade 9? How long did high schools students continue to enroll in mathematics courses? What was the highest level mathematics course taken by high school graduates? Are there differences across locations?

The distributions for percentages of students in Urban Fringe and Central City high schools are nearly identical with no statistically significant differences. Just over one-half of high school graduates, irrespective of location, en-

Table 3

Percentage of Students by Highest Level of Mathematics Course Taken in Ninth Grade and Location

Location	Less than Algebra I	Algebra I	Geometry	Algebra II	Calculus or Adv. Math
Rural	19 (1.6)	59 (1.9)	16* (1.5)	5 (1.1)	1 (0.4)
Urban Fringe	15 (1.2)	56 (1.7)	21 (1.3)	7 (0.8)	1 (0.5)
Central City	14 (1.2)	57 (2.2)	22 (1.7)	5 (0.8)	1 (0.5)

Note. The standard errors of the statistics appear in parentheses. Some rows do not sum to 100% because of rounding.
*Significantly different from other location at $p < 0.05$.

Table 4

Percentage of Students for School Location by Last Grade Level Mathematics Course Taken

Location	10^{th}	11^{th}	12^{th}
Rural	5* (0.5)	33* (1.2)	62* (1.3)
Urban Fringe	2 (0.3)	25 (1.1)	73 (1.2)
Central City	2 (0.4)	27 (1.5)	70 (1.7)

Note. The standard errors of the statistics appear in parentheses. Some rows do not sum to 100% because of rounding.
*Significantly different from other locations at $p < 0.05$.

rolled in Algebra I in the ninth grade (Table 3). As might be expected, very few students in any location enrolled in Algebra II (5%-7%) or Calculus or Advanced Mathematics (1%) as high school freshmen. A significant difference ($p < 0.05$) occurs in the percentage of students enrolling in Geometry. Rural students were less likely than their peers in other locations to enroll in Geometry in the ninth grade. Instead, a larger percentage of them enrolled in mathematics course below the level of Algebra I. With the ubiquitous Algebra I – Geometry – Algebra II sequence in US high schools, these data suggest that a small percentage (approximately 5%) of Rural high school students tend to begin their high school experience studying a lower level of mathematics than their counterparts in Urban Fringe or Central City high schools.

Table 4 shows the percentage of high school graduates in each location and the last grade level when a mathematics course was taken. Most notable in this table are the significant differences between the percentages of Rural high school students taking their last mathematics course at each grade level compared to the percentages of students in either Urban Fringe or Central City high schools. Rural high school students appear to take their last mathematics course sooner than students in other high schools in other locations. More than one-third of Rural high school students took their last mathematics course prior to their senior year, whereas the percentages for Urban Fringe and Central City high school students are 27% and 30%, respectively. Coupled with the number of mathematics credits earned (Table 2), we begin to see that Rural high school students are less likely to persist with their studies in mathematics as long as high school students in other locations.

A closer look at the data provides evidence that a higher percentage of Rural high school students ended their mathematics studies at a level below that of students in high schools in other locations. Table 5 shows the highest level of mathematics course graduates took in high school by location. When compared to students in other locations, graduates of Rural high schools were more likely to end their mathematics education at Algebra I or below. Consequently, they were less likely to end their studies in Advanced Mathematics (statistically significant difference with both Urban Fringe and Central City) or Calculus (statistically significant difference with Urban Fringe). Less than 40% of Rural high school students studied Advanced Mathematics or Calculus, whereas nearly half of graduates from Urban Fringe high schools completed their high school mathematics studies in Advanced Mathematics or Calculus. The profiles for the highest mathematics course taken in high schools of Rural and Central City schools are more similar, although nearly twice as many Rural high school students ended their studies at Algebra I or below (11% for Rural, 6% for Cen-

Table 5

Percentage of Students by Highest Level of Mathematics Course Taken in High School and Location

Location	Algebra I or below	Geometry	Algebra II	Advanced Mathematics	Calculus
Rural	11* (0.9)	14 (0.9)	37 (1.7)	26† (1.3)	12* (1.2)
Urban Fringe	6 (0.7)	13 (0.8)	32 (1.2)	32 (1.5)	17 (0.9)
Central City	6 (0.7)	14 (1.5)	35 (1.7)	27 (1.6)	18 (1.7)

Note. The standard errors of the statistics appear in parentheses.
*Significantly different from other locations at $p < 0.05$.
†Significantly different from Urban Fringe at $p < 0.05$.

Table 6

Percentage of Students by Mathematics Course Taught and Location

Location	Pre-Calculus or 3rd Year Algebra	Other Calculus	AP Calculus AB	AP Calculus BC	AP Statistics
Rural	92 (2.3)	51 (4.7)	58* (3.8)	17* (3.1)	17* (3.7)
Urban Fringe	97 (1.2)	59 (4.3)	84 (3.1)	43 (3.7)	43 (4.0)
Central City	96 (1.2)	52 (4.7)	84 (3.1)	44 (4.9)	44 (4.5)

Note. The standard errors of the statistics appear in parentheses.

tral City) and 50% more Central City high school students studied Calculus than Rural high schools students (12% vs. 18%).

Mathematics Course Offerings

Does the highest level of mathematics course taken by rural high school students tend to be less than that of students in other locations? We know that rural schools, especially those with small enrollments, often have a limited mathematics curriculum (Barker, 1985; Greenberg & Teixeira, 1998; Haller et al., 1993). Does access to advanced mathematics classes, particularly Calculus and AP Statistics, differ by school location? Table 6 shows the percentage of graduates attending high schools where the indicated mathematics course was offered. (This does not mean students actually enrolled in the course.) Pre-Calculus or a third year algebra course was offered in high schools of over 90% of students, regardless of location. Graduates from rural high schools had significantly less ($p < 0.01$) access to Advanced Placement (AP) mathematics classes than their counterparts attending high schools in other areas. This difference is more notable given the overall sample size is larger than 26,000. AP Calculus AB was offered in schools of 84% of Urban Fringe and Central City students, but in the schools of only 58% of Rural students. AP Calculus BC classes were offered less often to students in all schools: about half as much for Urban Fringe and Central City and one-third as much for Rural. AP Statistics was taught in schools at all locations at the same percentage as AP Calculus BC. Although Rural students have much less access to AP Calculus (AB or BC), other Calculus classes were taught in just over half of schools in all locations. Although these courses are offered to students, fewer than 20% (12% of Rural students) of students enrolled in a Calculus course (Table 5).

Conclusions & Discussion

The results from the HSTS data provide a look at the mathematics course-taking of rural high school students and shows how it compares with students from high schools in other locations. We summarize the findings as follows:

- The number of mathematics credits required for a standard diploma is similar for students, regardless of location. Slightly more mathematics credits tend to be required of Rural high school students while fewer mathematics credits tend to be required of Central City high school students.
- In general, students attending school in all locations earn more mathematics credits than

required for a standard diploma. Over half of all high school students earn more than 3.0 mathematics credits. A higher percentage of rural high school students earn fewer mathematics credits than their non-rural counterparts.

- Compared to graduates from non-rural high schools, Rural high school students are more likely to begin high school in a lower level mathematics course, take their last mathematics course earlier, and conclude their high school mathematics education in a lower course.

- The opportunity to study advanced mathematics courses, specifically AP Calculus and AP Statistics, is less available to Rural students than non-rural students.

These findings highlight four features of mathematics education in rural areas. First, it is not unexpected that mathematics course requirements are somewhat consistent across school location since minimal requirements (either specific courses or number of credits) for high school diplomas are determined at the state level in 45 states (Reys, Dingman, Nevels, & Teuscher, 2007). When determined at the state level, requirements apply to all high schools in the state regardless of their location. The slight increase in mathematics credit requirements for graduates in rural high schools may be a result of small rural schools with fewer electives requiring more credits in existing course offerings. Still, the number of mathematics credits required of students in high schools in any location falls short of the 4.0 credits recommended by the National Council of Teachers of Mathematics (2000). Yet, well over half the students earn more than 3.0 mathematics credits. However, the percentage of rural high school students (65%) earning more than 3.0 mathematics credits is lower than the 71% of Urban Fringe and Central City high school students earning the same number. Thus, more than one-third of rural high school students earn 3 or fewer mathematics credits in high school.

Second, when the number of credits earned, the highest level of mathematics course taken in ninth grade, the last grade a mathematics course was taken, and the highest level of mathematics course taken in high school are considered together, we begin to see a difference between the mathematics education of rural and non-rural students. Why are rural students beginning behind their counterparts in other locations? Why do they not continue in mathematics as long? The lower percentage of students taking Geometry in ninth grade and the higher percentage taking a course less than Algebra I (see Table 3) suggest that students in rural high schools lag slightly behind their peers in other schools in the mathematics preparation at the start of high school. Algebra courses in the middle grades are becoming more prevalent (Kilpatrick & Gieger, 2000) and groups such as the National Mathematics Advisory Panel (2008) advocate for more students enrolling in Algebra by Grade 8 (p. 23). Do students in rural schools have the opportunity to study Algebra prior to high school? Rural schools are particularly impacted since they often have small class sizes and few teachers. Cogan, Schmidt, and Wiley (2001) noted that, based on data from 1995, rural schools are less likely than schools in suburban areas and mid-sized cities to offer Algebra or other more challenging courses to students in the eighth grade. Middle grade teachers on the whole are impacted by these changes since many have elementary certifications and are underprepared to teach the content previously taught in high school (Chazan, 2008). Since the evidence suggests rural high school students begin high school slightly behind their peers from high schools in other locations and there are differences in Algebra course offerings in the middle grades, additional research is necessary to determine the challenges and solutions needed to ensure all students have access to a comparable mathematics education.

Next, less than two-thirds of rural high school students take a mathematics course in their senior year (see Table 3). Why do rural high school students not persevere longer in mathematics courses? There are several potential answers to this question (Anderson, 2006, in press). First, some students perceive advanced mathematics classes to be useful only for those planning to attend college or have a career in engineering or science. Second, other students do not find studying mathematics to be worthwhile or meaningful with traditional teacher-centered classroom practices. Third, students in rural communities may connect advanced study in high school mathematics with leaving the community in pursuit of education or employment opportunities not available in their community. In fact, teachers in rural schools often put students who are motivated and capable on a path to leave the community (Carr & Kefalas, 2009). Jobs or careers in historically rural industries such as farming, fishing, logging, and mining often do not have substantial formal mathematical requirements. High school mathematics teaching is often the only job in a rural community for someone with a post-secondary mathematics background. As a result, enrollment in advanced high school mathematics may not be a priority for students in rural areas. We should be cautious not to fault students for the apparent mathematics course-taking gap. There are factors both within the classroom (e.g., qualifications of teachers, instructional strategies) and beyond the classroom (e.g., course offerings, encouragement to study advanced mathematics, tracking) that contribute to unequal opportunities for rural high school students (Flores, 2007).

Finally, the dearth of AP mathematics courses shows a clear disadvantage in the rural high school mathematics curriculum. This may be a result of small enrollments in advanced courses or a limited numbered of teachers qualified to teach AP courses. We must be cautious, however, as students can have access to advanced mathematics courses through other avenues. For example, distance learning programs, online courses, or dual-credit options are ways some rural high schools provide learning opportunities for students (Robinson, 2003). Planty, Provasnik, and Daniel (2007) note that although schools in rural areas are less likely to have AP courses, they are more likely to offer courses for dual-credit where students receive both high school and college credit for the same course:

> Public schools located in rural areas were less likely to report offering AP courses (50 percent) than public schools in cities (77 percent), urban fringe areas (87 percent), and [small] towns (72 percent). Dual-credit courses, in contrast, were less likely to be offered in public schools located in cities than in public schools located in towns or urban fringe areas (65 vs. 79 and 74 percent, respectively). 70 percent of rural schools offered courses for dual credit (p. 6).

While dual credit options with a community college are available for some rural high school students, it is not clear from the data if students are taking advantage of that opportunity.

Limitations & Future Research

It is important to be mindful that the groups under comparison in national data sets, such as the one used in this study, are not homogeneous. Rural students are no exception. Factors such as race, ethnicity, and socioeconomic status interact with the rural locale. Students attending school in poor rural areas may be of special concern since less qualified teachers and lower funding levels are more typical of these schools (Flores, 2007). Additional research should be conducted to determine whether the differences – in students' participation in mathematics courses and in the opportunity to study advanced mathematics courses – observed in this study are still present when controlling for race, ethnicity, or socioeconomic status. The NAEP Data Explorer used for this study did not allow for this type of analysis.

Also, we acknowledge that the HSTS dataset contained only students who graduated from high school. The data provided no indication of the mathematics courses taken by those students who failed to complete high school. Is the mathematics education of these students less than the students reported in this study? Is mathematics a barrier for rural students to graduate from high school? Does location of high school impact the answer to these questions? While important, these questions are beyond the scope of this study, but interesting avenues for future research. Further, do rural students who do not finish high school view their mathematics education differently from those students in other locations?

Finally, this study addresses the mathematics course-taking of rural high school students. As mentioned earlier, several large-scale studies have examined mathematics achievement at the introductory high school level with the conclusion that high school students' mathematics achievement is comparable across school location. But further research should investigate the mathematics achievement of students at the advanced level and the connection to the mathematics courses studied by high school students. Does differential access to Algebra in eighth grade affect students' achievement in advanced high school mathematics? Does differential access to advanced mathematics courses (i.e. AP Calculus, AP Statistics) produce differences in mathematics achievement across the school locations? Is advanced mathematics content available to rural high school students through online or dual-credit options and do these produce the same mathematics achievement as an AP course? There are methodological difficulties in doing this type of research because of the tracking that exists in most U.S. high school mathematics programs (Kilpatrick & Gieger, 2000). Still such studies would provide a more complete picture of the current state of mathematics education for rural high school students.

In conclusion, results of rural students' mathematics achievement show few differences when compared to students in other locations (e.g., Howley & Gunn, 2003). Rural high school students' mathematics course-taking patterns do, however, present a contrast to students in Urban Fringe or Central City high schools. This is particularly noticeable for students taking advanced high school mathematics courses. Additional research is needed to ascertain if mathematics achievement gaps exist at the advanced levels since national standardized assessment tests typically assess only introductory high school mathematics topics. Thus, the data reveals a rural vs. non-rural course-taking gap in advanced mathematics. Rural students are completing required mathematics courses but do not seem to be pursing mathematics to the same level of their counterparts in non-rural areas. This implies that rural schools must have strong elementary and middle school mathematics programs so students can begin high school in Algebra I or Geometry. The mathematics courses taken throughout high school must be meaningful and relevant to the students. Furthermore, teachers and researchers must work together to develop ways to help students cultivate an intrinsic interest in studying mathematics and promote the external opportunities available when students in any location have a strong mathematical education.

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