**Advantages or Disadvantages?**

**Access to Advanced Math and Science Courses in Rural Schools**

# Objectives

Rural high school students are as varied individually as students anywhere in the country and as deserving of opportunities to participate in advanced math and science courses. Indeed, many rural high school students have strong academic abilities and live in families and communities that value postsecondary education. Perhaps in partial response to these families’ values, one of the top priorities of the National Rural Education Association (n.d.). is college and career readiness and preparation for postsecondary experiences.

By some measures, the future seems bright for rural students. The overall achievement of rural students varies, but on average they score higher than their non-rural peers on the Nation’s Report Card (Showalter, Hartman, Johnson, & Klein, 2019), and the gaps in achievement among white, black, and latinx students are smaller (Gagnon & Mattingly, 2018). Rural students are also more likely to graduate from high school compared to non-rural students (Aud et al., 2013; Snyder & Dillow, 2012).

But by other measures, rural students appear to be at a disadvantage. Compared to peers in other parts of the country, they are less likely to pursue postsecondary degrees (National Student Clearinghouse Research Center, 2016). As adults, they are less frequently employed in lucrative jobs, such as those requiring advanced science and technological expertise, and they tend to earn lower wages (Moller & Stearns, 2012).

Could it be that rural students have less access to the types of advanced math and science courses that would prepare them for postsecondary experiences and careers? Could other factors such as the poverty levels and demographics of rural schools make a difference? This study addresses these questions.

# Framework

Many studies show that students who take advanced high school level math and science are more likely to go to college, stay in college, and complete their degrees (e.g. Long, Conger, & Latarola, 2012; Morgan, Zakhem, & Cooper, 2018; Radunzel & Noble, 2012). Furthermore, building a high quality curriculum, that includes advance courses, is key to educational equity, ensuring that all students have the opportunity to learn and succeed (Kane, Owens, Marinell, Thal, & Staiger, 2016; Kotok, 2017; Steiner, 2017; Steiner, Magee, & Jensen, 2019). Offering advanced courses may be particularly important for rural students, especially those in school serving high percentages of students of color and students from low-income communities.

We have some evidence that rural students simply don’t have the same access to advanced math and science courses as other students. Past studies using data from the early 2000s showed that rural students were less likely to participate in advanced math courses than urban students even when their achievement was similar (Irvin, Byun, Smiley, W & Hutchins, 2017). Rural students have also been less likely to participate in advanced science courses when compared to their peers in non-rural places (Croft & Moore, 2019). These differences may have long term effects and could contribute to the gaps in math knowledge identified by rural community college faculty (Harmon & Wilborn, 2016) and to lower wages found among adult graduates of rural high schools (Moller & Stearns, 2012). Data on this issue needs to be updated and explored further.

Lack of opportunities to participate in advanced courses may be compounded by other factors. Several studies have found that schools serving students from low-income communities and communities of color also have less access to advanced math and science courses (Leung, Cardichon, Scott, & Darling-Hammond, 2020; Nowicki, 2018). In general, examining data based on the intersectionality of students’ identities provides a more nuanced and accurate description of social phenomena (Harris & Leonardo, 2018). Therefore, data analyses need to differentiate rural places by the types of students served.

Identifying this potentially inequitable access to advanced math and science courses in rural areas is particularly important, because improving course offering may be welcome in many of these rural places. Given their natural resources and access the outdoors, rural areas may be especially rich areas to study science, technology, engineering, and math (Avery, 2013). Furthermore, when given opportunities to participate in advanced math and science tailored to rural students, researchers have found that rural teachers and students do participate and that this participation increases their appreciation of math and science (Harmon, Tate, Stevens, Wilborn, & Adams, 2018; Ihrig, Lane, Mahatmya, & Assouline, 2018). Designing advanced math and science courses around the needs and strengths of rural communities has been found to contribute to increased math and science course taking, as well as college going and persistence (Peters Burton, Kaminsky, Lynch, Behrend, Han, Ross, & House, 2014; Peterson, Bornemann, Lydon, & West, 2015).

Given the potential benefits of advance math and science learning in rural places, this study seeks to document equitable access to advanced math and science courses in rural schools. It does this by exploring current advance math and science course offerings in rural schools and by examining how these offerings differ for rural schools serving higher than average proportions of students of color and students from low-income families. The study addresses the following questions:

1. How do course offerings in advanced math and science differ in rural and non-rural areas?
2. How do course offerings in advanced math and science differ in rural and non-rural areas particularly for (a) schools serving higher than average percentages of students of color and (b) schools serving higher than average percentages of students from low-income communities?

# Data Source and Methods

Within the 2017–18 Civil Rights Data Collection (CRDC), 14,823 schools met our definition of a high school—that is, a school that offers all four grade levels from grade 9 through 12, does not offer grades 8 or below, has 10 or more students, and is not a juvenile justice facility. We combined this dataset with the “locale codes”—city, rural, suburb, town— and with “free and reduced-price lunch (FRPL)”—an indicator of poverty—in the National Center for Education Statistics Common Core Data. Of the original set of schools, 14,576 high schools had data for locale code and 14,287 also had data for FRPL.

Using these data, we first examined the percentages of schools offering algebra 2, advanced math, calculus, chemistry, and physics by locale code. Next, we explore these percentages when we limited the dataset to schools that served higher than average percentages of students of color (i.e., all students who were not identified as white) and higher than average percentages of students from low-income families.

In all analyses, we used chi squares to examine the statistical significance of differences in course offerings across groups.

# Results

We found that overall rural schools were sometimes at an advantage for offering advanced courses and sometimes at a disadvantage (Figure 1). Significantly more rural schools (95%) offered Algebra 2 in 2017-18, compared to non-rural schools (92%). Similarly, significantly more rural schools (91%) offered chemistry, compared to non-rural schools (89%). However, rural schools were at a significant disadvantage in offering calculus (64% in rural schools and 71% in non-rural schools) and were at a similar disadvantage in physics (73% in rural schools and 80% in non-rural schools).

Examination of data for rural and non-rural schools serving higher than average percentages of students of color told a different story (Figure 2). For Algebra 2, these rural schools maintained a slight but non-significant advantage. Disadvantages for rural schools remained significant for calculus (only 49% of rural schools offered the course compared to 62% of non-rural schools) and in physics (only 61% of rural schools offered the course compared to 74% of other school). Interestingly, the rural school advantage in chemistry disappeared: 85% of rural schools serving higher than average percentages of student of color offered this course while 87% of similar non-rural schools offered it.

Results for rural and non-rural schools serving students from low-income communities were similar to the results overall (Figure 3). Rural low-income schools (93%) were significantly more likely to offer algebra 2 than non-rural schools (90%). In contrast, smaller percentages of rural schools (47%) offered calculus compared to non-rural schools (59%). Similarly, smaller percentages of rural schools (61%) offered calculus compared to non-rural schools (72%).

Another way to look at these data is to compare the data across rural schools. This comparison shows that those rural schools serving higher than average proportions of students of color and students from low-income communities are consistently less likely to offer these advanced courses (Figure 4). The percentage point differences are largest in the courses that rural schools offer statistically less frequently than non-rural schools: calculus and physics. For example, among rural schools serving higher than average percentages of students of color and among those serving students from low-income, only 61% offered calculus compared to 73% of all rural schools and 80% of all non-rural schools.

# Significance

Using the most recent year of the CRDC, we found that, overall, rural school were sometimes at an advantage for offering advanced math and science courses and sometimes at a disadvantage. However, when our analyses focused on schools serving higher than average proportions of students of color and on schools serving higher percentages of students from low-income families, the data revealed a different pattern. These analyses both showed that the percentages of these rural school offering these courses were consistently lower. This was particularly concerning for school serving higher than average proportions of students of color. These schools were consistently less likely to offer advanced math and science compared to their non-rural school counterparts that also served higher than average proportions of students of color.

More research is needed to understand the mechanisms behind these data. For example, we know that both rural schools and school serving high proportions of student of color and students from low-income families are less likely to have experienced and fully certified teachers (Cardichon, Darling-Hammond, Yang, Scott, Shields, & Burns, 2020). Could a shortage of qualified teachers be a factor in course offerings in rural schools?

Furthermore, the CRDC data allow only limited understanding of school context and course content. Aspects of the rural experience not represented in these quantitative data, such as parental aspirations for their children and students’ interests, likely influence the courses rural schools offer. What could qualitative studies of rural schools tell us by exploring the experiences of students in rural classrooms and by gathering the insights of educators, community leaders, and parents?

Despite these opportunities for future research, we have enough data to know that action is needed. Students in rural schools, regardless of ethnicity or family income, need equitable opportunities to take advanced math and science courses. Increased course offerings could be supported by increased funding to rural schools through federal grants such as the Rural, Low-Income Schools program and the Rural Education Achievement Program. State leaders could also reexamine their funding formulas to help ensure that funds are distributed in ways that support rural schools, especially those serving students of color and students from low-income communities.

# Figures

Figure 1. Percentages of Rural and Non-Rural Schools Offering Advanced Math and Science Courses, 2017-18 (n = 14,576)

\* *p* < 0.05

\*\* *p* < 0.001

Data sources: U.S. Department of Education, Office for Civil Rights. (n.d.). Civil Rights Data Collection (public-use data files for 2018). https://ocrdata.ed.gov/; National Center for Education Statistics. (2018). Common Core of Data. https://nces.ed.gov/ccd/ccddata.asp (accessed 11/20/20).

Figure 2. Among Schools Serving Higher than Average Percentages of Students of Color - Percentages of Rural and Non-Rural Schools Offering Advanced Math and Science Courses, 2017-18 (n = 6084)

\*\* *p* < 0.001

Data sources: U.S. Department of Education, Office for Civil Rights. (n.d.). Civil Rights Data Collection (public-use data files for 2018). https://ocrdata.ed.gov/; National Center for Education Statistics. (2018). Common Core of Data. https://nces.ed.gov/ccd/ccddata.asp (accessed 11/20/20).

Figure 3. Among Schools Serving Higher than Average Percentages of Students of Eligible for Free or Reduced Price Lunch - Percentages of Rural and Non-Rural Schools Offering Advanced Math and Science Courses, 2017-18 (n = 6584)

\*\* *p* < 0.001

Data sources: U.S. Department of Education, Office for Civil Rights. (n.d.). Civil Rights Data Collection (public-use data files for 2018). https://ocrdata.ed.gov/; National Center for Education Statistics. (2018). Common Core of Data. https://nces.ed.gov/ccd/ccddata.asp (accessed 11/20/20).

Figure 4. Percentages Among Types of Rural School and Among Non-Rural Schools Overall Offering Advanced Math and Science Courses, 2017-18

Data sources: U.S. Department of Education, Office for Civil Rights. (n.d.). Civil Rights Data Collection (public-use data files for 2018). https://ocrdata.ed.gov/; National Center for Education Statistics. (2018). Common Core of Data. https://nces.ed.gov/ccd/ccddata.asp (accessed 11/20/20).

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