
Wayne School of Engineering: Case Study of a Rural Inclusive STEM-Focused High School

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Rural schools face challenges that are often different than nonrural schools. Resource constraints are particularly acute in rural schools, and they struggle to offer advanced courses and extracurricular programs. The purpose of this paper is to present a descriptive, instrumental case study of an inclusive rural science, technology, engineering, and mathematics school that has successfully dealt with challenges and offers an innovative and productive learning environment, despite limited resources. For this study, a variety of on-site and off-site data collection techniques were used such as focus groups, classroom observation protocols, and surveys. Wayne School of Engineering (WSE) overcomes resource barriers by matching their schedule to the local community college, upgrading the rigor of their high school classes and facilitating student transition to college. WSE also requires extracurricular research projects that help students see the relevance of their in class learning, build 21st century skills, and connect to partners outside of the school. Faced with limited budgetary, technological, and logistical resources, WSE administrators, teachers, and students work collectively to overcome these barriers and provide high-quality education by finding ways to blur the lines of traditional secondary schools.

Rural schools face challenges that are often different than nonrural schools. Resource constraints are particularly acute in rural schools, and they struggle to offer advanced courses and extracurricular programs (National Center for Educational Statistics, 2009). These schools often find that creating and maintaining outside-of-school partnerships are difficult because of geographic location. Although resources provided to schools tend to be declining, administrators are still faced with increased achievement expectations (Williams & Nierengarten, 2011). Rural schools tend to serve large minority and socioeconomically disadvantaged populations (Lichter, Roscigna, & Condrón, 2003; National Center for Educational Statistics, 2009). Because of their small size and limited resources, teachers are often teaching multiple content areas (Brown & Swanson, 2003; Colangelo, Assouline, & New, 1999) and have little access to professional development opportunities (Barley & Beesley, 2007). Dropout rates tend to be higher than in nonrural schools (Rural School and Community Trust, 2010), and there is a documented gap between rural students' academic performance and what

teachers believe these students could achieve (Hardre & Sullivan, 2009). In spite of major obstacles, rural schools offer advantages over nonrural schools in areas such as community support (Hardre, 2007; Howley, 2009; Woodrum, 2009), role modeling (Ballou & Podgursky, 1995), and programs tailored to local resources (Faircloth, 2009; Woodrum, 2009). Rural communities, being small in size, often have strong connections among families, schools, and religious institutions (Coleman, 1988; Crockett, Shanahan, & Jackson-Newsom, 2000; Elder & Conger, 2000). Thus, rural schools are more advantaged in local social resources, yet they face a variety of other obstacles in supporting quality educational experiences for all students.

There is a national awareness of the challenges faced by rural schools, and efforts to improve these conditions often leverage science, technology, engineering, and mathematics (STEM) resources. STEM funding has been used to support facilities, administrative structure, curriculum design, teacher preparation, career awareness, and school support networks in an effort to provide opportunities to

rural schools (National Science Foundation, 2013). The purpose of this paper is to present a descriptive case study of an inclusive rural STEM school that has successfully dealt with the challenges faced by rural schools and offers a productive learning environment, despite limited resources.

Selection of School

This case study is a portion of a larger National Science Foundation-funded project, Multiple Instrumental Case Studies of Inclusive STEM-focused High Schools: Opportunity Structures for Preparation and Inspiration (OSPrI; Lynch, Behrend, Peters-Burton, & Means, 2012; Peters-Burton, Behrend, Lynch, & Means, 2014). The goal of the OSPrI study is to find and characterize 12 “exemplar” inclusive STEM-focused schools (ISHS), schools that do not use academic criteria for admission that require that the students to demonstrate that they are gifted and talented in STEM or very high achievers, and conduct an analysis across the cases. Schools included in the OSPrI study were selected with three criteria: They must (a) self-identify as STEM school, (b) take in a range of students who choose to attend a STEM-focused school, and (c) be well-established within their school district and/or state and have reputations for success with its student population in comparison to school district or state averages. Schools were nominated by experts in the field and categorized according to promising elements in their design and outcomes. The school selected for this case study was Wayne School of Engineering (WSE) located in Goldsboro, North Carolina. WSE was selected because the state of North Carolina has a large inclusive STEM high school initiative, and it was one of the first schools involved in the New Schools Project funded by the Bill and Melinda Gates Foundation. WSE is now one of four laboratory schools that showcase successful practices to visitors wanting to build their own inclusive STEM school.

The current case study is driven by the following research question:

1. In what ways does the WSE deal with the challenges of rural schools, specifically rural STEM schools?

Method

Study Design

Instrumental case study. This study employs an instrumental case study design (Stake, 1995, 2006; Yin, 2008). This method provides insight to a purposefully selected exemplar school described by narrative data through systematic and consistent means. Research using

this method to study school-level redesign include SRI International studies of International Baccalaureate programs (Bland & Woodworth, 2009), Knowledge Is Power Program (KIPP) schools in San Francisco (David et al., 2006), small high schools and their learning cultures (Shear et al., 2005), and Chicago’s Renaissance Charter Schools (Young et al., 2010). This method is ideally suited to the study because it is a thorough approach to studying new school models such as ISHSs and promises rich results. It provides a means for rigorous case analysis but also is open-ended, allowing new empirical evidence and interpretation to inform the research.

Data sources. This study uses multiple data sources for triangulation (George & Bennett, 2005), for example, conducting focus groups with teachers and with students as well as classroom observations. The data sources were created to focus on the design and implementation dimensions of 10 critical components found in Table 1. Focus groups and interviews with administrators, teachers, curriculum specialists, students, outside partners, and parents were used to inform curriculum design and implementation, technology usage, learning opportunities outside of the classroom, the nature of external partnerships, early college coursework, professional development, interpretation of mission, administrative structure, and supports for students. Classroom observations were conducted using Reformed Teaching Observation Protocol adapted for STEM classrooms (RTOP; Piburn et al., 2000) and the Lesson Flow Classroom Observation Protocol (LFCOP; Lynch, Szesze, Pyke, & Kuipers, 2007), as well as artifact analysis of syllabi, lesson plans, and student products. Student products included nomenclature activities in chemistry, maps of planting grids for earth science, and examples of parabolas in everyday life from mathematics. These instruments were used to describe the level of rigor and types of learning opportunities implemented at the school. Artifact analysis of school websites, application procedures, high-stakes test scores, and other relevant online information was conducted to describe design elements of the curriculum, informal learning opportunities, STEM partnerships, early college opportunities, and inclusive STEM mission. A survey designed for the OSPrI project was given to WSE teachers online to describe teacher background and perceptions of the school. In order to describe the extent to which the school was well-established, data were collected on district and state databases for student attendance and graduation rates, and achievement on STEM-related district and state tests (above or below district and state averages) to provide comparable descriptive statistics for the ISHS.¹

Table 1
Critical Components

Component Name	Description
1. STEM-focused curriculum	Strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.
2. Reform instructional strategies and project-based learning	STEM classes emphasize instructional practices/strategies informed by research for active teaching and learning and immersing students in STEM content, processes, habits of mind, and skills.
3. Integrated, innovative technology in use	The school's structure and use of technology has the potential to change relationships among students, teachers, and knowledge, and flatten hierarchies.
4. Blended formal/informal learning beyond the typical school day, week, or year	Learning opportunities are not bounded, but ubiquitous. Learning spills into areas regarded as "informal STEM education" and includes apprenticeships, mentoring, social networking, and doing STEM in locations off of the school site, in the community, museums and STEM centers, and business and industry.
5. Real-world STEM partnerships	Students connect to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day.
6. Early college-level coursework	School schedule is flexible and designed to provide opportunities for students to take classes at institutions of higher education or online.
7. Well-prepared STEM teaching staff	Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers.
8. Inclusive STEM mission	The school's stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented.
9. Administrative structure	The school's structure for governance.
10. Supports for underrepresented students	Supports such as bridge programs, tutoring programs, extended school day, extended school year, or looping exist to strengthen student transitions to STEM careers.

Data Collection

Before the research team visited the school, public information on WSE was collected, a series of structured previsit telephone interviews were conducted with the principal and the school curriculum specialist, and the principal filled out an extensive survey regarding the critical components seen in Table 1 and other important aspects of the school's design, model, and goals. Once this information was collected, the school's curriculum specialist worked with the research team to direct the scheduling of classroom observations, focus groups, and interviews with teachers, administrative staff, students, parents, and members of the community including business/industry and higher education experts closely involved with the school for the planned school visit.

A six-person team (authors of this case) traveled to the school in fall of 2013 for a 4-day site visit. In most cases, each data collection activity was conducted by two researchers working in tandem and was designed to have content specialists present for relevant activities. For instance, during an 11th-grade mathematics classroom visit, a mathematics educator and a science educator employed two classroom observation instruments, the RTOP and the LFCOP, while watching the same lesson. Assigning two researchers per activity block helped to

optimize the reliability of the data collected, and assisted with triangulation and interpretation of the observations and interviews.

After the school visit, researchers followed up with the curriculum specialist and principal to clarify any questions that occurred during the visit. The research team checked the accuracy of their understanding of the case findings at WSE with the school staff by sending the final case study to the principal of WSE, who then confirmed the correctness of the case.

Data Analysis

Immediately following the site visit, the data for each activity were examined for clarity and were converted to electronic form and placed into NVivo (QSR International Pty Ltd, 2006). The team members read the data for each of the activities in which they participated (e.g., focus group and observation) while judging the relevance of each activity to the codebook (Smith, 1987) of the 10 critical components proposed by the OSPri project. Coding was done in iterative cycles. The first cycle of coding consisted of segmenting the text data into discrete units (Straus, 1987) and labeling the segments of text into one or more of the 10 critical components. For example, if a teacher discussed the use of tablets in their classroom, it would be coded for critical components 2 and 3. This cycle

of the coding was done for each activity by the two members of the research team who collected the data. One of the pair of researchers independently coded the data and then passed their coded data to the other member for checking. Discussions of the choices made for coding were conducted between the pairs until there was consensus. Once there was consensus, the codes were attached to the data in NVivo and reports of each critical component were generated, examined so that there was consensus about that data that were identified as critical component 1 and as critical component 2 and so on. A second cycle of coding was conducted with the same logistics as the first, but with attention toward emerging themes that were not included in the critical components, such as school culture or 21st century skills. Emerging themes have been important to the larger OSPRI project because “school culture” was not initially identified as a critical component, but this theme was pervasive across the data from the eight schools visited and may be a major component.

Placement into NVivo software allowed for the codes that were identified on each activity to be reorganized into separate documents for each critical component. Research team members were assigned to critical components that corresponded with their expertise. From the codes organized by critical components, researchers developed themes and occurrences within the critical components that characterized the school and discussed these themes with the research group. The group added detail drawn from the data to the themes and occurrences or filled gaps in understanding when necessary. Following the group discussions, each research member developed a narrative to answer the following questions: (a) In what ways were the critical components present at the school? And (b) to what extent were the critical components present at the school?

Findings

As of the 2000 census, there were 39,043 people, 14,630 households, and 19,465 families residing in the city of Goldsboro. The population density was 1,574.9 inhabitants per square mile (708.1/km²). The major industry is swine production, and Wayne County is home to Seymour Johnson Air Force Base. About 10.2% of families and 13.8% of the population of Wayne County were below the poverty line. WSE serves a diverse body of 325 students with demographics that closely mirror the population of the City of Goldsboro (36,743 in 2011): 47% of the student body is White, 31% African American, 7% Hispanic, and 15% are of two or more races (Joyner & Marsh, 2011). In the 2009–2010 school year, 57% of

these students were considered economically disadvantaged (i.e., eligible for free and reduced lunch program) (National Center for Education Statistics [NCES], 2013).

WSE is situated in two buildings adjacent to the entrance of the local comprehensive high school, Goldsboro High School (GHS). One building houses the high school and the other houses the new middle school. WSE and GHS are connected and share a library, parking lot, and nearby public space that includes athletic facilities. WSE is located next to a public library and public park, both of which are available for use by the school.

WSE has a curriculum that focuses on STEM, including courses in robotics, biomechanics, and solid modeling. Instruction at the school features problem-based learning, an integrated mathematics curriculum, access to online courses through a virtual high school, up to 15 hours of college credit, and an internship to be completed before graduation. The school also has partnerships with the New Schools Project, Wayne Community College (WCC), and East Carolina University. WSE opened in the fall of 2007 with a core group that included the principal, four teachers, one counselor, and 74 ninth graders. It added a class of students in its first four years and has since served students in grades 9 through 12. WSE had its first graduating class in the spring of 2011. In the fall of 2012, WSE expanded to include students in grade 6. WSE will continue by adding grade 7 in 2013 and grade 8 in 2014.

School History and Design

Prior to 1992, students who attended WSE would have been served by either the local City Public Schools or County Public Schools, based on the geographical location of their residence (Wooten, 1991). Starting on January 1, 1992, the two school systems merged to become Wayne County Public Schools. However, aside from these administrative changes, no fundamental changes occurred to reverse a pervasive White–African American racial divide within the system. In 1994, the parents, school boards, and students from five of the state’s counties sued the state and the State Board of Education, arguing that the state did not do enough to provide their children with a quality education. The judge in the case “chose 10 of the lowest performing high schools in the state and said something had to change at these schools” (WSE Principal, interview, September 7, 2012), which included GHS. The current WSE principal, at the time an assistant principal at the comprehensive high school, worked with the district’s director for high school education to write a successful application for a planning grant to develop innovative high schools. To improve opportunities for students in the

central attendance zone, they proposed to start a new school, WSE (Jonsson & Khadaroo, 2010). Permission was given to begin WSE: “We started with one math, one English, one science, one social studies, and one counselor. Just the basics.” (Associate Superintendent, interview, September 27, 2012). The state provided the principal’s salary, and additional bus transportation to bring students from across the district, with some living as far as 35 miles away, and the district supported the teachers’ salaries. The goal for the new school was to collaborate with government, business, and higher education to improve STEM education in the district.

Admissions and Coursework

Today, students from various attendance zones across the district are admitted to WSE through a lottery system. The admissions process at WSE is intentionally designed to be inclusive. Applications are made available on the WSE website each January. Teachers visit all of the County middle schools to present information about WSE and distribute recruitment materials. The applications must be handwritten by the student and accompanied with two recommendation forms from staff members at their current middle school (WSE school website) along with a copy of the student’s discipline profile and attendance record (WSE school website). Until 2011, the WSE admissions committee interviewed potential students, but the applicant pool became too large.

In 2007, WSE’s first year, there were 74 applications, and all were admitted. There were approximately 100 applications in the second year, and by 2011, WSE had approximately 200 applications, resulting in half of the applicants being admitted by the lottery. The increase in applicants indicates that the community is well aware of WSE and values the school’s learning opportunities. Incoming WSE students come from all parts of Wayne County, and an indicator of performance of students before they attend WSE can be found from End of Grade tests of Wayne County students, which report the following pass rates for 2007–2009: mathematics 63.2%, 67.1%, and 81.5%; reading 84.9%, 50.4%, and 63.6%; and science 2007 not available, 45.2%, and 61.3%.

Instruction at the school features student-centered instruction (Coalition of Essential Schools, 2013), integrated mathematics (Common Core State Standards Initiative, 2013), a senior internship, and opportunities to take courses online to earn college credit. Students at WSE are expected to take four years of science, four years of mathematics, and four years of engineering, requirements well beyond state standards. The school has strong partnerships with a local community college (2 miles away

from WSE), East Carolina University (42 miles away), and the North Carolina New Schools support network. Students who were admitted in 2012 are eligible to stay for an additional year of community college courses to earn an associate’s degree in arts or in science at no cost to the student. WSE does not offer an athletic program, but students in grades 9–12 can participate in the athletic program at the neighboring comprehensive school. Aside from this athletics programs overlap, WSE’s teaching staff, facilities, and students remain separate from the comprehensive school.

Courses are taught in an intensive semester schedule to create cohesive contact among the students and between the students and the teacher. For example, chemistry courses meet for 80 minutes each day and conclude in one semester. The intense, shortened course schedule corresponded to the local community college’s schedule so that students may seamlessly take courses on WSE’s campus as well as at the local community college. The rigor of WSE courses, such as biology, is high as compared with the state as a whole. For the two semesters prior to the site visit, the teachers state that their students had a 93% and 95% pass rate on the state biology exam. In the discipline of mathematics, WSE students had more students at or above grade level in algebra 1 (80%) than GHS (59%), Wayne County (72%), and North Carolina (79%). WSE is well known by community members for the rigor offered in the courses (parent focus group, September 27, 2012).

WSE has a distance learning program where students can take additional coursework online—either through a virtual high school or through the local community college. The facilities for this program include two distance learning labs at school. Alternatively, students can take these classes online at home. Students can choose to remain at WSE for a fifth year and earn an associates of arts or an associates of science from the local community college, and the state will pay for their books and courses. Because of the partnership with the community college, there is a great deal of flexibility in the levels of classes that students can take. A mathematics teacher explained “some students need 5 courses to get them ready for calculus, whereas other students only take 2 courses here at WSE before they are ready” (Teacher 3, interview, September 26, 2012).

All students at WSE take honors courses, and the instructional model teachers strive for is inquiry-based teaching and student-centered learning that is focused on the state’s learning standards. These instructional models are adopted purposefully with the expectation that teach-

ers collaborate in cross-curricular lessons and build relationships that support student learning.

We don't want a school where the teachers are just necessarily the givers of information. We want the students being inquisitive and questioning and discussing and that is what I tell folks when I am hiring them—is it's easy to create a lesson plan where you are the center of attention, but then I want you to create a lesson plan where the students are doing the work. (WSE Principal, interview, 9/28/2012).

Of the 12 classes observed during the site visit, student-centered learning occurred 75% of the time, where students worked individually or in small groups to learn the content, but the instructional model used was not always inquiry or problem-based learning, although STEM classes tended to emphasize hands-on instruction in small groups and were interactive. This percentage was measured by the LFCOP, which accounts for instructional practices for each 2-minute interval. The learning that occurred in these classes was characterized by student lead small-group discussions, student presentations of new information, students working in laboratory settings, and working in small groups to solve problems or design solutions.

Student Performance Outcomes

Algebra I, English I, and biology end-of-course (EOC) exams are all measures that indicate that WSE students perform at a very high level as seen in Figure 1. Student performance on the EOCs is reported in achievement levels ranging from I to IV. Students are considered to be

at or above grade level if they receive a score of Achievement Level III or IV on the EOC tests.

Generally, across all three subjects, WSE outperforms the comprehensive high school, county, and state in each demographic subgroup, particularly on the biology assessment among other economically disadvantaged students, African American students, and female students as seen in Figure 2.

Overall, WSE graduates a higher percentage of its students than all three comparable groups. The 2011–2012 graduation rate for all students at WSE (94.7%) easily surpasses the rates for the local comprehensive high school (68.5%), the county (80.1%), and the state (80.4%). Additionally, WSE had higher graduation rates for their economically disadvantaged students (95%) as compared with the local comprehensive school (78.6%), the county (77.7%), and the state (74.7%). WSE also graduates over 95% of their Hispanic and African American students compared with rates in the mid-70s for the nearby comprehensive school, county, and state.

Early College Experiences

A partnership with WCC expands the curricular offerings available to students in their high school career. Generally, students take the introductory level courses in mathematics, science, and engineering at WSE, and then if recommended by the principal, they are free to take any of the advanced offerings at WCC. This creates an environment where the majority of the students who attend in person on the WSE campus consist mainly of freshmen and sophomores, while the upperclassmen are often off-campus attending courses at WCC or taking online courses at home in the morning before they come in for afternoon coursework at WSE. Using a thumbprint reader at the front door to sign in and sign out, most of the juniors and seniors at WSE only come to campus for one period a day, and take courses online or at the community college for the remainder of the day.

College courses are a priority in the personalization of classes. Students who are taking college courses first obtain the college schedule, and then the WSE schedule is fit to the college schedule. If the high school level courses do not match, then students have the opportunity to take the courses online. Most WSE students begin college coursework before their senior year, with some as early as ninth grade. The WSE administration allows students to enroll in courses at the community college depending on student performance. The principal personally approves the students who apply to take college courses, and he states,

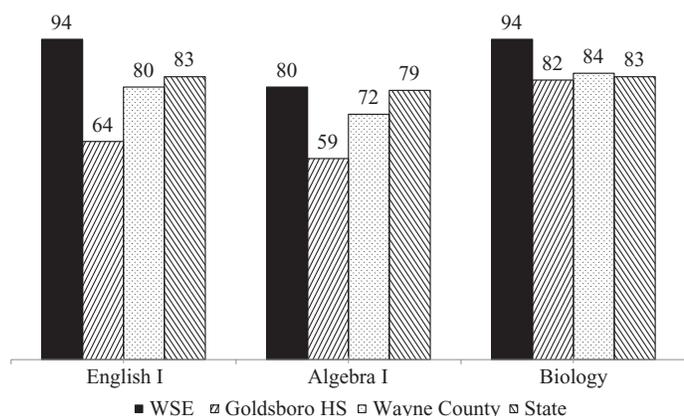


Figure 1. 2011–2012 ABCs EOC test results for WSE, comprehensive high school, county, and state (per cent at or above grade level, for all grades tested).

Source: “Education First NC School Report Cards” from North Carolina Education First website (retrieved from <http://www.ncreportcards.org/src/> on October 31, 2012).

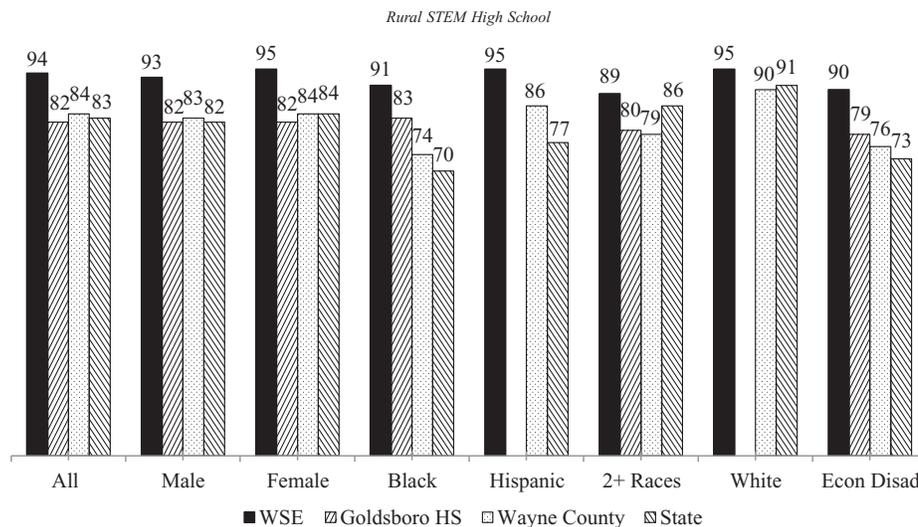


Figure 2. 2011–2012 biology EOC test results for WSE, comprehensive high school, county, and state (per cent at or above grade level, for all grades tested, disaggregated by gender, ethnicity, and economic condition).

Source: “Reports of Disaggregated State, School System (LEA) and School Performance Data for 2010–2012” from North Carolina Public Schools Accountability Services Division website (retrieved from <http://www.ncpublicschools.org/accountability/reporting/leaperformancearchive/> on January 4, 2013).

Students have to prove they’re ready here before we allow them to go over there and take those courses. We look at their report cards and I sign everyone’s report card and we give the ones we feel are ready a release form. (Principal, interview, September 26, 2012).

WSE monitors students’ grades on college coursework and “pulls them back” if needed into high school courses and supervised online coursework as described by a school administrator: “Some students aren’t ready for the community college scene, so we have to keep them here on our campus to take electives” (Principal, interview, September 28, 2012). If the students achieve an A for the year in the elective course taken at WSE, they are offered a release form for the following year. Students who are struggling are assigned to meet with peer tutors, WSE teachers, and/or the counselor to have additional time to work through academic difficulties.

The pass rate for all WSE students taking college courses (freshmen to seniors) was 94.5% in 2012. With such a successful partnership, the college would like to expand its offerings at WSE. Mechanical engineering is the focus of the engineering courses, and the department at the college would like to offer all types of engineering courses to WSE students, including industrial systems technology, electronics engineering, sustainability technology, and operations management. Practical considerations including space and logistics issues need to be solved as this partnership moves forward. “I want

them to finish two years of college if they can before the end. That is our goal for every one of them. Some don’t do it. Some get 15 hours of college work, and I would be happy with that. It’s whatever they can do is where I want to push them” (Principal, interview, September 7, 2012). WSE students first take engineering classes taught by a core group of WCC engineering instructors at the high school, and students can then take additional engineering courses at WCC. During the 2011–2012 academic year, WCC instructors taught two courses at the high school each semester: auto CAD drafting and computer aided manufacturing. About 10% of WSE students during 2012–2013 pursued an associate’s in engineering, and a significant number of others take the courses offered at the high school taught by WCC engineering teachers for dual credit. In addition to engineering, some students take lab-based science classes at WCC.

Extending Resources and Personalizing Instruction

The critical components of STEM-focused curriculum and early college-level coursework were prominent features at WSE. The structure of the curriculum and the partnership with the local community college was designed to provide additional resources not found at WSE and to offer a more personalized curriculum through early college experiences. Incoming students are varied in what they have learned and are able to do. The students come from middle schools throughout the large rural district, and many are children whose parents are in the military

and who have lived all over the world. WSE works to personalize the program for them and meet them where they are as they enter the school. Later on, as students advance, there are increasing opportunities to use the resources of the community.

It's built into everything we do, it's very personalized. Every kid that goes here is not going to college. However, we try to give options and opportunities. If they want to take college classes, they have to prove themselves, and once they do, we try to do all we can do to push them in that direction . . . They start taking college classes as early as freshmen, and some of our juniors and seniors, we don't even see. They clock in and out . . . So this is a lot of freedom. (Curriculum specialist, interview, September 7, 2012).

The students appreciate this flexibility, and one pointed out that he thought that it was possible because the school is so small. The rural area in which WSE is located does not offer as many opportunities in STEM as more populous areas, so WSE takes all the resources available and funnels them to the students, using the community college, university, and online learning, as well as 4-H, tutoring opportunities, and small collaborations with local activists and educators.

The nurturing environment is generated by the school's small size and the close relationships of the students, teachers, and the principal. Parents also indicated that the small class size contributed to their and their children's choice to apply to WSE, as well as student success in the coursework. Ninth graders described incidents of caring attention from their teachers and peers, while eleventh graders talked about knowing all the freshmen. Students reported that they feel free to seek help from any teacher, not just a specific teacher of a course they are taking. This is facilitated by the small size of the school and positive relationships among all members of the school community.

After WSE students complete integrated mathematics I/II/III, they have the option to take a college mathematics course to satisfy their fourth mathematics requirement. AP calculus is also an option offered at the high school with the possibility of getting college credit depending on their exam score and the college policy for awards of college credit. Some students take all the mathematics courses offered by WSE and also take additional mathematics courses at WCC. According to a WSE administrator, most WSE students satisfy their graduation mathematics requirements by the second semester of their sophomore

year because students can take a full mathematics course each semester. Because of the variety of classes offered at WCC and the flexibility of WSE scheduling, students' coursework becomes personalized.

WSE has limited resources and space to offer a variety of different courses. WSE gains flexibility in their course offerings and deals with limited resources by strategically partnering with WCC. Giving students opportunities to take college courses is a priority for WSE, as evidenced by the graduation requirement of WSE students to take 15 college credits. This opens up a variety of different subjects that would not be taught at a traditional school and increases the rigor of the courses. Taking college courses early with effective support also sets up students to have high self-efficacy in their ability to pass college coursework. Students who see themselves as successfully taking college courses are more willing to continue their work in a four-year college setting.

Dealing with Technology Limitations

The WSE School District has developed a comprehensive technology plan that outlines the role technology is expected to play in student learning. The vision statement declares, "In [the local] County Public Schools, all students and staff will experience continuous academic and personal growth through the effective use of current and emerging technologies, thereby preparing them for life in the 21st Century." The plan goes on to assert that every class in the county will be a "technology-based environment." Technology is implemented with two primary goals. The first is to make sure county students are able to use technologies to prepare themselves for future work. The second goal for technology use is effective and creative uses of technology will help its schools meet the needs of a wide variety of students. Thus, the county's design for technology use is to supplement traditional educational methods while preparing students to use technology after they graduate from high school.

On the whole, technology use at WSE can be characterized as resourceful, although not especially innovative, integrated, or plentiful. Teachers, students, and administration are creative in finding ways to accomplish their goals despite limited technology resources, but most people feel that they could be more effective if these resources were more developed. In a statement that captures this dynamic, the principal states, "Everything's out of warranty, so I'm the technology repair guy. My limited knowledge, I'll take it apart, fix the keyboard, put new keys on them. We just make do" (Principal, interview, September 14, 2012). Challenges with old and outdated technology create many problems for teachers, who must be resourceful to solve

them. “Our computers are limited and the ones we have do not always work. When I do get to use them, I have to devise class with two separate lessons, objective, and products to allow the other half to work in partners to do the above” (Teacher 7, survey, August 23, 2012). Students often use their own devices, such as phones or tablet computers, to accomplish their schoolwork. Thus, resourcefulness and overcoming challenges are unexpected features of the way technology is used to support teaching and learning. The physical laboratory facilities at WSE were also limited, and similar to the computer technology, teachers at WSE still found ways to make learning student centered. At a district level, the use of the technology is a struggle because of the rural context. Nonetheless, members of the WSE community, teachers, administrators, and students alike work together to share their expertise to create the most effective learning environment possible.

Building a Sense of Community

Small schools allow personalization, a major theme of WSE. Each student is known as an individual, and the student’s classes and activities are planned around that knowledge and the maturing student’s evolving abilities, interests, and needs. Consequently, access to the school’s resources in advanced coursework depends on the student’s progress. This requires that all of the educators at WSE know their students well and work together to garner supports and resources, allowing them to be flexible in helping students to find opportunities in this rural, dispersed, and generally nonaffluent community.

Supports for students in general take the form of tutoring when needed, college advising, helping students gaining access to courses at the community college or to other opportunities for leadership and growth in the community, and a school culture that has been built to be supportive, nurturing, and tolerant. WSE believes that college preparedness is for all students and has put together several systems in its design to support that belief. The faculty sees tutoring outside of class time as part of their jobs and is willing to work with students who need extra help staying after school or meeting with students before school when there is a need. What is remarkable is that there seems to be little stigma attached to needing a tutor—rather it is regarded as natural. This is especially true for the mathematics program where students seem to require extra help to succeed. “I don’t know where it is coming from, but the kids are able to learn . . . My daughter has been tutored massively with her math teacher” (Parent 4, focus group, September 28, 2012). In addition,

students may tutor one another, or work in groups for projects. The electronic communication system facilitates these collaborations.

There is a weekly advisory period for students assigned to one teacher for just this purpose. In the first years of the school, the advisory cut across grade levels, but currently the staff finds it preferable to keep students in the same grade together so that they can tailor the discussions to student progress through WSE, and then outside the school to access community resources. College admissions advising plays a role for older students. The advisories also allow time for character education, team-building activities, a look at what is happening in students’ world, and how to improve the school. WSE was designed to support the kinds of students that it attracts to its STEM program and focus on college admission so the supports seem woven into the fabric of the school and involve all of the students and staff. Because resources are not plentiful, support for students comes first and the school’s bureaucracy is of lesser importance.

Extending the Class Day

Students are required to complete a grade-level project for every year that they attend WSE. Grade-level projects are primarily conducted outside of school time, which promotes meaningful academic engagement beyond the school day. The projects offer students an opportunity to engage with real-world organizations and investigate issues about which students are passionate. The grade-level projects also help contribute toward WSE’s culture and emphasize community service to the students. The freshman-year project is focused on scholarly research and allows students to apply their research to one of the core curriculum courses. The sophomore-year project provides students with an opportunity to engage in community service activities. Students are required to volunteer for 20 hours of community service during the school months. Most students volunteer at either a program where they tutor other students at WSE, GHS, or other high schools in nearby counties or at a nearby community garden (where students learn about gardening techniques and food sustainability issues). Students present their work to local community leaders and write a paper on social issues, reflecting on their community service experiences. The junior-year project expands upon the sophomore year project and asks students to take their community service experience and begin to think globally. Juniors are required to volunteer for 40 hours of community service during the school months, and most students choose to continue volunteering with the organization that they volunteered at during their sophomore year. At the end of the

junior-year project, students are required to complete a research paper on the global issues they discovered in community service, applying skills learned in their first-year project and integrating reflections from their sophomore-year projects. Finally, the senior-year project is focused on cultivating WSE students' career interests and providing them with real-world work experience. Seniors are expected to intern at a nearby organization for 60 hours during the school months. Seniors are expected to find the internships themselves; however, they can receive some assistance from their guidance counselors or other adults. The senior-year project culminates in a paper in which the students research a potential career and include details about their own experiences. Grade-level projects are yet another way that WSE provides an extended, personalized academic experience for students even with limitations due to their geographic location.

Summary

WSE can be characterized as a rural inclusive STEM school that provides a quality, personalized education by capitalizing on its available resources. Similar to other rural schools discussed in educational literature, WSE is composed of a tightly knit community of students, teachers, administrators, parents, and partners (Hardre, 2007; Howley, 2009; Woodrum, 2009). WSE is more than an institution of learning; WSE provides a sense of place that coalesces student pride. Students and parents are aware that WSE provides opportunities that are not found in the surrounding schools, and they sense that they are in a special, caring place that encourages students to persevere in the face of limited resources (Coleman, 1988; Crockett et al., 2000; Elder & Conger, 2000). The community of WSE works together to continue to improve their academic experience through grant writing, bringing in guest speakers, seeking out volunteer opportunities for all students (Faircloth, 2009; Woodrum, 2009), and perhaps most importantly, helping each other to learn, no matter if you are a student, teacher, or administrator (Ballou & Podgursky, 1995).

WSE overcomes other barriers such as having a small modest physical facility and teachers who are teaching at capacity by matching their schedule to the local community college (NCES, 2009). In doing so, WSE is able to extend its course offerings to those of the community college and, in turn, upgrading the rigor of their high school classes for smooth student transition to college (Provasnik et al., 2007). This approach is not particularly innovative, but WSE has been effective in identifying opportunities in their community, such as WCC and

extracurricular research projects, that can extend the curriculum and individualize their educational experiences (Williams & Nierengarten, 2011). Taking courses at the college level when still in high school not only increases the rigor, variety, and personalization of the instruction, but it also builds student self-efficacy toward successful completion of college coursework (Provasnik et al., 2007). Students are expected to explore their community and find a place within that community in order to complete the grade level extracurricular project while synthesizing their knowledge. The parent, student, and teacher buy-in to the WSE model encourages student responsibility for learning and the accountability across grade levels results in a smooth transition to college-level courses.

WSE is an excellent example of a school that leverages its community, both within and outside of the school, to accomplish the goal of higher expectations of academics. The students test scores on end of course exams (biology, algebra I, and English) are higher than surrounding schools, the district as a whole, and the state, even though many other schools in the state have more resources. Faced with limited budgetary, technological, and logistical resources, the core of WSE's success is girded by the school's ability to work collectively to find community resources and blur the lines of traditional secondary schools. Future schools may look to the case study of WSE to find applicable components that could be successfully scaled, however keeping in mind that scalability depends on the context. Viable components that have merit for application in other schools, based on this study, are the development of partnerships with higher education and building a school culture that values rigor in education. Schools that do not have proximity to community colleges could examine possibilities offered by online courses. The successful components at WSE are not rooted in innovation, but in the creative use of external resources, community buy-in, and accountability for students, which sends an optimistic message to schools with waning funding who are also seeking a more rigorous educational environment.

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Authors' Note

¹ Such comparisons provide rough estimates of the relative achievement of ISHS students but do not take into account differences in students' prior achievement or STEM interests before entering high school.