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Factors Contributing to Rural High School Students' Participation in Advanced Mathematics Courses

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Factors Contributing to Rural High School Students' Participation in Advanced Mathematics Courses

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In recent decades, researchers, educators, policy makers, and others have been concerned with students' mathematics achievement and their participation in mathematics courses. Mathematics educators argue that mathematical knowledge is necessary for *all* individuals since economic, social, and political opportunities depend on it (D'Ambrosio, 1990; National Council of Teachers of Mathematics [NCTM], 2000; Moses & Cobb, 2001). *Principles and Standards for School Mathematics* draws attention to this with the equity principle: "Excellence in mathematics education requires equity – high expectations and strong support for all students" (NCTM, 2000, p. 12).

In an effort to realize a high quality mathematics education for all students, a growing body of research literature has tracked the mathematics performance of several groups of students while attempting to understand the conditions contributing to differences in their mathematics experiences. For example, studies have examined the mathematics education of female students (Ansell & Doerr, 2000; Boaler, 1997), African-American students (Martin, 2000; Ladson-Billings, 1997; Lubienski, McGraw, & Westbrook, 2004), Hispanic students (Gutstein, 2003; Khisty, 1995; Strutchens & Silver, 2000), and students from differing socio-economic backgrounds (Lubienski, 2000; Task Force on Mathematics Teaching & Learning in Poor Communities, 1998). Less is known about the mathematics education of students in rural areas although recent efforts have contributed significantly (e.g., Gibbs, Swaim, & Teixeira, 1998; Harmon, Henderson, & Royster, 2003; Howley, 2003; Howley & Gunn, 2003; Kifer, 2001; Silver, 2003).

The mathematics education of students in rural areas of the United States is important because these students comprise a sizeable number of students and they attend a significant number of schools. More than 20% of public school students in the U.S. attend school in a small town or rural area (Beeson & Strange, 2003). Rural schools are typically smaller than schools in non-rural areas so they comprise greater percentage of schools. Beeson and Strange note that nearly one-third of the schools in the U.S are located in rural areas.

Students attending rural schools have different experiences than students attending schools in non-rural areas since rural schools are typically smaller in size (Beeson & Strange, 2003), are less likely to have advanced course offerings (Barker, 1985; Greenberg & Teixeira, 1998), and are farther from colleges or universities (Gibbs, 1998). Additionally, students in small rural schools often have significant contact with their teachers both in and out of school (Nachtigal, 1992). All courses offered in a particular discipline may be taught be one or two teachers so students are with the same teacher for multiple years. As a result students and teachers get to know each other academically and personally.

The focus of this paper is a group of rural high school students and the factors that contributed to their participation in mathematics classes beyond those minimally required for high school graduation. I follow Gutiérrez (2002) in referring to *participation* as course taking, particularly in elective and advanced mathematics classes. I begin by describing the research methodology and research setting, a small high school in a rural community in the U.S. Pacific Northwest. Then I present and discuss survey results. I next introduce readers to three students enrolled in advanced mathematics classes (Pre-calculus or Calculus). Drawing on interview data, I highlight some of the factors they offered for enrolling in elective mathematics courses. I conclude by discussing the students' responses and offering suggestions to increase rural student enrollment in advanced mathematics courses.

METHODS

The data presented in this paper were collected as part of a qualitative research study conducted with the purpose of exploring (1) the practice of mathematics education in a rural high school, (2) the relationship between the rural context and mathematics education, and (3) factors contributing to rural high school students' participation in advanced mathematics classes (Anderson, 2006). This paper emphasizes the third purpose.

Data for the study were collected using ethnographic techniques: observation, interviewing, and review of documents (Wolcott, 1999, p. 46). The research was conducted over a three-month period of time at Cedar Valley High School[1]. During that time, mathematics classes were observed; students and teachers were interviewed; and math textbooks, worksheets distributed in class, and other information about the school were among the documents reviewed. Prior to interviews, students were also administered a survey that solicited demographic data and contained items relating to students' mathematics beliefs and attitudes (*Fennema-Sherman Mathematics Attitude Scales*: Fennema & Sherman, 1976; Mulhern & Rae, 1998; *Indiana Mathematics Beliefs Survey*: Kloosterman & Stage, 1992; *National Assessment of Educational Progress*: Kloosterman & Lester, 2004; Silver & Kenney, 2000).

The results in this paper are drawn from survey responses from all students in the Pre-Calculus and Calculus classes at Cedar Valley High School who volunteered to participate in the study. All of the students in these two classes were enrolled in a mathematics course beyond the two classes required by CVHS for high school graduation. These students were either juniors or

[1] Names of locations, students, and teachers are pseudonyms.

seniors. The sample group consisted of 14 of the 16 students enrolled in the Pre-calculus class and one of the four students enrolled in the Calculus class. Approximately 20% of the juniors and seniors at CVHS were enrolled in one of these two mathematics classes.

After the survey was administered, nine of the students were selected for individual, semi-structured interviews. Eight of the students (four female/four male) interviewed were enrolled in Pre-calculus and the remaining student (female) was enrolled in Calculus. The interviews ranged from approximately 30 to 60 minutes and included students' views on the math curriculum, math classes, math teachers, the community, the school, and their post-secondary plans. Interviews were also conducted with two teachers of mathematics. These semi-structured interviews addressed the teachers' background, the mathematics curriculum and classroom, the students, community, and school. In this paper, the observations, documents, and interviews with the teachers served to triangulate the interview and survey data from the students.

RESEARCH SETTING

The research site was selected based on its "rural" characteristics – small population, isolated mountain community, historically dominated by timber industry – and the availability and willingness of the school to participate in the study. To my knowledge, no research or outside interventions had been conducted in mathematics education at the school prior to this study.

During the ten years she had been teaching at the school, the mathematics teacher had taken her own initiative to promote the math classes to the students through informal advising and, she said, "more 'advertising,' more selling the programs." In this section I provide a description of the community, the school, and the mathematics classes in order for the reader to better understand the environment of the students' experiences of mathematics education.

Community

The students attended a small high school in Cedar Valley, a rural community in the U.S. Pacific Northwest. Nestled in the forested mountains of the region, approximately 3500 residents made their home in the Cedar Valley School District. No incorporated cities existed within the boundaries of the district, but homes were clustered in a handful of neighborhoods throughout the district. The school, post office, fire station, gas station, convenience store, church, and café formed a small local commercial center. Recently developed housing areas shared the countryside with older, more established homes and neighborhoods. A paved state highway bisected the district connecting the Cedar Valley neighborhoods and secondary roads. This highway was roughly perpendicular to an interstate freeway it intersected a few miles outside the district boundaries. Cedar Valley was classified "rural and outside a metropolitan statistical area (MSA)" by the United States Office of Management and Budget (United States Census Bureau, 2004). Cedar Valley was located approximately 20 miles from the county seat (population 35,000). The nearest large metropolitan area (over 1,000,000 residents) could be reached by car in approximately one hour.

The timber industry, a typical "rural" industry (Hobbs, 1992), had shaped the economy of Cedar Valley. Trees in the heavily forested areas provided a source of income and work for settlers in the area. Several decades ago large cedar, hemlock, spruce, and fir trees were plentiful. Mills were built to make cedar shingles and other building materials. After fifty years of intense logging, most of the old-growth forested areas were eliminated and timber companies turned to re-planting the area with fir trees. This marked a turn for the traditional timber industry in the area and a decline in the number of people employed in that industry.

The economic changes were reflected in the demographics of the community. At the time of this study, most Cedar Valley residents lived on the side of the district nearest the interstate highway with convenient driving access to the nearby county seat where there were mills, factories, a shopping mall, national retail outlets, professional services, and a community college. Government statistics indicated the average commute time of a Cedar Valley resident was 30 minutes, likely to the county seat approximately 20 miles away. The timber industry remained an employer for many in the community whether it was logging in the forests, working at a sawmill in the community, employment in related industries, or commuting to mills in other communities such as those in the county seat. Tourist services and seasonal work were also available to many of the residents. Unemployment data for Cedar Valley specifically were not available, but in the county 7%–8% of the people were unemployed during the time of the study. The state unemployment rate at the same time was just less than 6%. Historically, the county had unemployment rates above that of the state. From 2001 to 2003, the annual unemployment rate was over 10% (Bureau of Labor Statistics, 2004).

In my interviews with the students, they frequently described the community as “small” and “friendly.” They reported that logging and tourism were common sources of employment in the area and that hunting and fishing were favored pastimes for many. James struck on several features of the community, descriptors also used by other students.

> I would say [Cedar Valley is] a logging or a “hick” community. I mean – I hate using that word, but we are. We all drive lifted vehicles, including myself. SUVs and trucks, very few import cars around here. I mean there are a couple, but you know, it’s not like

> [larger cities] where you see a lot of Hondas, Mitsubishis, or higher class, BMW or whatever. You see more like Ford trucks and Toyotas and Chevys and stuff like that. One thing that we like to do is four-by or, you know, go play in the snow. Stuff like that, outdoor stuff. And so that's why I say we're a hick community. Plus we, like I said – drinking. Go party out in the woods. Go camping a lot. Hunt, that's a big thing. Hunting and fishing is huge in this community. (James, grade 12)

Although James's description highlights his personal view of the community, other students shared this perspective, at least partially. A "hick" community, outdoor recreation, and drinking/drug use were each themes mentioned by at least three of the fourteen students interviewed. Several of the students alluded to the outdoor recreational opportunities available, including hunting and fishing. Even if they did not enjoy or participate in those particular activities, they had friends or family members for which they were important part of living in Cedar Valley.

School

Students in all grades, kindergarten through grade 12, attended the Cedar Valley School. The school grounds contained a cluster of seven buildings, mostly single-story, in addition to a greenhouse and grandstand by athletic fields. There were baseball and softball fields, a football field and track, and a playground on the premises. The elementary school classrooms were housed in two adjacent buildings while the junior and senior high classes were held in two other adjacent buildings. The district office and high school principal's office were located with the senior high classrooms. A multipurpose room (which also served as a lunch room), agriculture building, and high school gym and locker rooms completed the school. A wood and metal shop was located at the back of the high school gym.

At the time of this study, there were 323 students enrolled in grades 7 through 12. In the previous six years, graduating classes had ranged from 36 to 51 students. Cedar Valley students' cohort on-time graduation rate in recent years had been over 80% with annual dropout rates ranging from 3% to 7%. Over ninety percent of the students at Cedar Valley High School were white. Hispanic and American Indian/Alaska Native students each comprised about three percent of the student population. The remaining students were Asian/Pacific Islander (1.2%) or Black (0.1%). Twenty-five percent of students at CVHS were eligible for free or reduced-price lunch.

The teaching staff at Cedar Valley High School (Grades 7–12) consisted of twenty teachers. Five teachers had primary teaching responsibility for teaching classes to seventh and eighth grade students. Two other teachers split their time between teaching physical education and other duties. One of these teachers was the athletic director and the other had guidance counseling responsibilities. There were two teachers who taught mathematics classes full time – one for the high school classes and the other for the junior high and lower level math classes – and a third who taught both mathematics and history classes. Only the high school mathematics teacher, Ms. Jones, had undergraduate preparation in mathematics teaching. She regularly taught Algebra I, Algebra II, and Pre-calculus. She also taught Calculus the year of this study since there was sufficient student enrollment. This was the first time a Calculus class had been offered at Cedar Valley High School. Otherwise she taught Geometry when she needed another class to fill her schedule.

Nearly all of the students interviewed described the school as “small,” and most went on to explain that the result of a small school was that “everybody knows everybody.” Not only did all of the students know the other students, but they also knew the teachers and the teachers knew them. With a small student population, students reported there was more “one-on-one” time with the teachers. “Plus, the teachers know you. So they can do things based on their knowledge of you and not just their knowledge of a piece of paper that talks about you” (James, grade 12). The ability to be “up close and personal with the teachers” (Thomas, grade 12) was part of nearly every student’s description of the school. As Nachitgal (1992) points out, the social connections among teachers and students are likely to be more pronounced in small schools since they are likely to have contact with their teachers and peers in social situations outside the school.

Mathematics Curriculum

A typical mathematics curriculum was offered to students at Cedar Valley High School: Algebra I, Geometry, Algebra II, and Pre-calculus. Students were required to complete two years of mathematics courses to graduate. Most students enrolled in Algebra I during their freshman year, but some took that when they were in grade 8. Geometry was not a required prerequisite for Algebra II so some students enrolled in Geometry concurrently with Algebra II or Pre-calculus. Other students did not enroll in Geometry. If students were not prepared for Algebra I, they enrolled in Pre-algebra as a freshman. Several of these students fulfilled their mathematics requirements by completing a General Math class later in high school. As is more common in rural than in non-rural schools (Greenberg & Teixeira, 1998), calculus was not offered regularly at Cedar Valley High School. It was, however, offered for the first time during the year of this study. Four students were enrolled in the Calculus class. These students had either omitted Geometry from their high school mathematics program or took it concurrently with another math class so they could have time for Calculus during their senior year.

Mathematics Teacher

Ms. Jones was the mathematics teacher responsible for teaching most of the high school mathematics classes. She was also the department chair and so coordinated textbook adoption and helped plan the schedules of the other teachers. Ms. Jones had grown up and graduated from another high school in the county, near the county seat. Although she said she did well in math and "was in the honors math program all the way through high school… I had no plans to be a teacher in high school." She had attended a regional state university, intending to major in Environmental Science. She changed to mathematics education by the end of her first year and credits her calculus professor with changing her mind. "I had an incredibly good calculus professor and the way the registration worked, I couldn't get into biology. I got into calculus. She kept me in the department and got me a job at the tutorial center. Found out I was good at it and stayed in education." After completing college, Ms. Jones returned to the county and worked aa a substitute teacher for one year before being hired at Cedar Valley High School. At the time of this study, she was in her tenth year of teaching at CVHS.

Ms. Jones' profile is not uncommon among teachers in rural communities in that she attended a regional state university and returned to teach in her home area (Muse & Thomas, 1992; Nachtigal, 1992). In fact, Schmuck & Schmuck (1990) found that over 90% of the teachers in the 25 small-town schools in their study had, like Ms. Jones, grown up near the schools where they now taught.

Ms. Jones said she enjoyed teaching in a rural community with a small school. "I don't see me leaving. You know, I've gotten used to the small school…. I go into a bigger school and it's just like there's too many people." Although there are fewer students in a small school like Cedar Valley High School, each teacher is responsible for teaching a broader range of courses within their subject area. Ms. Jones had four to six different classes to prepare, depending on the year. Since she was the lone, regular high school math teacher, these classes covered the range of courses offered from Algebra I to Pre-calculus and Calculus. She viewed this as a benefit of her job: "I think I'd be bored silly if I had to teach the same class. It's bad enough right now where I've got three sections all doing trig graphing [two sections of Algebra II and one Pre-calculus class]." Although teachers in other rural schools may not share Ms. Jones' enthusiasm for teaching a number of different classes each day, it is a common occurrence for teachers in small rural high schools to teach several different classes each day (Nachtigal, 1992).

Mathematics Classes

"We've always stayed pretty traditional…. We haven't really changed it to the really 'out there' hands-on type of programs," Ms. Jones commented during an interview. This view of the mathematics classes was corroborated by my observations and comments from students. Senk and Thompson (2003) point out the difference in instruction as a result of different types of textbooks. Distinguishing between "traditional" and so-called "*Standards*-based" textbooks they write:

> When classes use traditional textbooks, typically teachers demonstrate how to do something and students work individually to reproduce what the teacher has shown them. In contrast, in classes using *Standards*-based materials, teachers often pose problems for

> students to work on in small groups, and that might be solved by using various strategies. (p. 15)

The classroom instructional activities, textbook, and the curriculum tasks in Ms. Jones' mathematics classes, reflected a "traditional" mathematics classroom with the teacher leading most of the activities and students work individually on short, decontextualized single-answer questions (Boaler, 2003).

This type of teaching is not atypical in mathematics classes in the United States. In fact, the teaching in Ms. Jones' classroom is similar to that of American classrooms reported by the TIMSS videostudy (Jacobs, et al., 2006; Stigler & Hiebert, 1999). Students' descriptions of a typical day in their math class highlight the expected routines of the day, the same routines evident in every math class I observed.

> We'd pretty much just come into class and we'd get out our previous day's assignment for correction. We'd correct them in class, usually. Then we'd go over some of them. If there were specific problems that a lot of people got wrong or didn't understand and didn't do or something, then she'd go over them in class and we'd have a chance to do them in class. That way, you know, people would be able to get past that step. After we'd correct our assignments, we'd move on to the next step. We'd start our next thing in the book, the next chapter, next assignment, or whatever. She'd teach that for a little while and go over it and kind of make sure people were comprehending it. Then she would give us our assignment and we'd have about half the class to work or maybe a third of the class to work on the assignment. (James, grade 12)

> We first corrected the assignment that we did the day before. Then we go over every problem that anyone had a problem with. Like, she explains it if we don't know how to

> do it. And then we either start something new or go on with what we did and get an assignment from there. And then it starts all over the next day. (Julia, grade 11)

> We usually come in. We look at the assignment. She usually writes down five or six problems and we go over them – the ones that were the hardest. She shows us how the correct way for them to be done. And then we turn them in. And then we get an assignment, or we take notes for awhile on whatever it is we're learning. Then start a new assignment. That would be typical. (Thomas, grade 12)

> A typical day? Just go in, have your work done. First the teacher explains how to do it. Like for the Pythagorean Theorem, for example, she tells you the steps for it. She shows you the right triangle, the leg, the hypotenuse, that sort of thing. She makes us write up notes so we can check back. And then after that she makes us do a couple and then if we all get it right, she shows us. She gives us time to work. Do it and after that she shows us the correct way to do it. If we got it right, then we know. She makes us move on and do an assignment. (Calvin, grade 12)

Several features of "traditional" mathematics teaching are apparent from these quotations from students. First we see that the teacher and textbook are the source of and authority for mathematical knowledge in the classroom (Cooney, 1994). For example Thomas said, "She shows us how the correct way for them to be done." Julia echoed this sentiment when she said, "[Ms. Jones] explains it if we don't know how to do [the homework]." In this classroom the teacher controls the solution methods available to the students by initially presenting solution methods to the students and later showing them her solution method to questions they missed (Stigler & Heibert, 1999). In the quotes above, the students have appropriately described the active “intellectual activity” of the teacher – explaining, teaching, showing, and working problems – while describing their more passive activities of listening, checking answers, and taking notes.

Another facet of the instructional activities of the classroom is the place of “answers.” The first part of most classes was devoted to the teacher giving answers and the students checking those answers. During this portion of the class the teacher provided answers to questions the students were not able to answer on their own. In the last part of the class, students worked on getting answers to the homework exercises. During this time, they checked their answers with other students and with the answer key at the front of the room. As discussed later in the paper, these features of the math class are one of the factors contributing to some students’ continued participation in elective mathematics classes but may have been a reason for other students to end their study of mathematics.

ENROLLING IN ADVANCED MATHEMATICS CLASSES

We now turn to the question: What factors contribute to students’ participation in advanced mathematics courses? NCTM (2000) states: “All students are expected to study mathematics each of the four years that they are enrolled in high school, whether they plan to pursue the further study of mathematics, to enter the workforce, or to pursue other postsecondary education” (p. 288). In high schools such as the one in Cedar Valley, where graduation requirements do not include four years of mathematics classes, students choose whether or not they will continue their mathematics education each year.

What influences their decision? What factors do they say contribute to their decision? Students in rural high schools are subject to the usual factors that influence decisions to take advanced mathematics classes, but they may also be facing fewer advanced mathematics course offerings. Greenberg and Teixeira (1998) have noted that students in rural high schools have less access to Calculus classes than their counterparts in non-rural schools. In 1994, more than 90% of urban high school twelfth-grade students were enrolled in schools that offered calculus while less than two-thirds of rural twelfth-grade students attended high schools that offered calculus. The difference is more extreme when considering school size. Calculus was offered in schools to 95% of students in schools with enrollments over 1000, but less than 60% of students in schools with enrollments less than 400. Cedar Valley High School was a small high school that did offer Calculus but, as mentioned earlier, it was offered for the first time during the year of this study.

On the written survey, students were asked to respond to the following item: List three reasons why you have taken more than 2 years of high school math classes. The responses from the students enrolled in the Pre-calculus and Calculus classes are presented in this section. Most of these students had been together as a class since elementary school. They had all taken at least two math classes from Ms. Jones. For most this was their third or fourth math class and, with the possible exception of their Geometry class (depending on the year they enrolled in geometry), Ms. Jones had been their teacher in each mathematics class. The students' responses were grouped into categories. A summary is shown in Table 1. Since students responded with three reasons, the percentage of students does not sum to 100%.

Table 1: *Factors Why Students Enroll in Advanced Mathematics Classes*

Factor in decision to enroll in advanced mathematics classes	**Percent of Students n = 15**	**Percent of Responses n = 38**
Liking mathematics, math class, math teacher	20%	11%
Personal development	47%	21%
Future – College	53%	32%
Future – Work	33%	16%
Future – General	20%	8%
Connection to Science	13%	8%
Other	20%	8%

Note: Each student provided up to three different responses.

Twenty percent of students indicated they enrolled in advanced mathematics because they liked mathematics, mathematics classes, or the mathematics teacher. Nearly half of the students saw their purpose in mathematics classes was for personal development. These students wrote statements such as: “I am not good at math so I try to do better,” “I want to expand my knowledge,” and “I want to challenge myself.”

Most students indicated they enrolled in advanced mathematics classes because they felt the classes were necessary for their future. Post-secondary education – admission to college or preparation for college classes – was a sizeable category. “More difficult math classes look better on college transcripts,” “Prepares me for college level math,” “It may help me earn scholarships,” and “Colleges look for them on applications” were a sampling of responses. Other students indicated they were looking to the future and studying advanced high school mathematics, specifically for work – “It can help me better understand statistics and get me prepared in the business area” and “Higher math for a better job” – and also more generally – “Taking all those math classes will hopefully help me in the future.” Two students wrote about the connection of mathematics with science: "I like science and advanced science classes require math" and "I want to know how [math] connects science to the 'real world'." A few responses did not fit into any of the previous categories. One student wrote, "I get good grades in math and it boosts my grade point average" while another responded, "It fit into my schedule."

The factors indicated by the students are not unexpected. In fact, many of them mirror the responses of African-American students attending Hillside, an urban school in the Bay area of California (Martin, 2000). Martin writes, "The students… contextualized the importance of mathematics and mathematics knowledge in either socioeconomic terms (i.e., necessary to get a "good" job) or as a prerequisite to the steps leading to a promising future (i.e., necessary to get into college" (p. 168). Like other students, over half of the responses from students at Cedar Valley High School indicate future educational and career opportunities influenced the students' decisions to enroll in either the Pre-calculus or Calculus classes.

The responses from students point out different relationships they have to their mathematics learning. That is, the factors suggest students' sense of belonging to the broader practice of mathematics education. Before turning to the interview data to get a closer look at three students' reasons for enrolling in advanced mathematics classes, I will discuss the students' survey responses within a framework of belonging (Wenger, 1998). Wenger (1998) describes three distinct modes of belonging: engagement, imagination, and alignment. Each mode of belonging suggests a different relationship of the students and their ongoing experience of mathematics education.

First, *engagement*, as a mode of belonging, involves the "active involvement in mutual processes of negotiation of meaning" (Wenger, 1998, p. 173). With respect to mathematics learning, most of the direct engagement occurs in the mathematics classroom. In the mathematics classroom, students and teachers negotiate what it means to learn mathematics, to do mathematics, and to be good at mathematics. Engagement is bounded by the time and place where students are in contact with learning school mathematics. While students may complete homework outside of school, the mathematics classroom is the focal point for their engagement with mathematics learning. Those students who wrote that they liked math and enjoyed math classes indicate a relationship to mathematics via engagement.

Boaler and Greeno (2000) have described how belonging to and engaging in a "traditional" type of mathematics classroom leads some students to eschew mathematics because "they wanted to pursue subjects that offered opportunities for expression, interpretation, and agency" (p. 187). In referring to the "school mathematics world" as the traditional mathematics classroom, Boaler (2000) also points out, "Some students are happy stepping into the school mathematics world, either because they find success there or because it offers a form of shelter or recluse from the interactional demands of real life" (p. 393). Students at Cedar Valley High School expressed similar feelings about their math classes. Several students liked the routine tasks of Ms. Jones' "traditional" mathematics classes (a description of Ms. Jones' mathematics classroom is provided in an earlier section) and thus felt a sense of belonging to the class. Because they liked engaging in the traditional mathematics classroom environment, they continued to enroll in mathematics classes beyond the two classes required for graduation. Calvin is an example of this type of student and his story is discussed in the next section.

Other students, however, were disaffected and felt they lacked the ability to put some of themselves into the class. They did not have a strong sense of belonging to the mathematics classroom. For example, Abby, a junior in Pre-calculus, favored art over math. She said, "In art you can just do whatever you want. But in math there's just kind of like procedure that you have to work through." The "traditional" mathematics teaching in the classroom promoted the view that mathematics is procedures that must be followed and answers to be found. Bishop (1991) has commented on the impersonal nature of this type of mathematics teaching: "A curriculum of right answers offers no scope for personal interpretation and invention. The rules must be learnt, the procedures accepted and the skills practiced" (p. 9). This seemed to be the case in the mathematics classes at Cedar Valley High School.

Students can also develop a sense of belonging through *imagination*. "Imagination refers to a process of expanding our self by transcending our time and space and creating new images of the world and ourselves" (Wenger, 1998, p. 176). Those students who saw their place in the mathematics classes in relation to their future were belonging through imagination. What Wenger (1998) says of stonecutters – one imagining making a perfectly square stone and the other imagining building a cathedral – applies to the students in the mathematics classes as well. Some students viewed their study of mathematics as a way to improve themselves, make them smarter, or be challenged, while others were preparing for college or work. "At the level of engagement, they may well be doing exactly the same thing. But it does suggest that their experiences of what they are doing and their sense of self in doing it are rather different. This difference is a function of imagination" (Wenger, 1998, p. 176).

Finally, students may belong through *alignment*. "The process of alignment bridges time and space to form broader enterprises so that participants become connected through the coordination of their energies, actions, and practices" (Wenger, 1998, p. 178–179). To put it another way, "Alignment is a process of translating imagination into action" (Nasir, 2002, p. 236). Many students saw themselves attending college in the future. They belonged through imagination but at the same time took action and aligned themselves with other college intending students. These students enrolled in advanced mathematics classes – along with College Prep English, foreign language, and other courses – required for the broader enterprise of admission to colleges and universities. That is, as they aligned their energy and actions in this way they had a sense of belonging to a broad group of high school students preparing for college.

The framework of belonging (Wenger, 1998) illustrates that students' course taking decisions are complex. Students are simultaneously members in the mathematics classroom, members of the broader world outside the classroom – and the places they imagine filling in the future, and guided by the requirements they perceive are necessary to become members of the other practices in the future.

STUDENTS' STORIES

Interview data from three students give us a deeper look at the reasons students offered for enrolling in advanced mathematics classes. These three students were selected from all of those interviewed because they illustrate a range of the responses from the students enrolled in advanced mathematics classes at Cedar Valley High School. As we will see, Calvin's stated reason for enrolling in mathematics classes was because he liked the classes and wanted to be a high school mathematics teaching. Elizabeth said she enrolled in the mathematics classes because she believed they would enable her to be qualified for college. An interest in a career with computers motivated Benjamin to studying mathematics throughout high school. Beneath the surface, each student also suggests other reasons she or he was enrolled in the advanced math classes.

Calvin: "Math is like a jigsaw puzzle waiting to be solved."

Calvin was a senior and enrolled in Pre-calculus. He had completed one math class each year, beginning with Algebra I in grade 9 and continuing with Algebra II and Geometry in subsequent years. His teacher and other students considered him to be a good student.

Like most of his classmates enrolled in the advanced mathematics classes at Cedar Valley High School, Calvin was the first in his family to be studying the mathematics topics of Pre-calculus. According to Calvin, his father had started college to be an elementary teacher but had dropped out after three years. "He just kinda stopped on his last year." At the time of the interview Calvin's father was working in a steel mill. "He works behind a desk, works behind a computer. He keeps inventory and all that." Calvin's mother cleaned houses. She had finished high school but had not taken many math classes. "My mom doesn't understand [math]…. My mom doesn't know it," he said. One of the few people that Calvin probably knew who had studied mathematics beyond high school algebra and "knew it" was Ms. Jones, the high school math teacher.

The reason Calvin gave for enrolling in the Pre-Calculus class was because he enjoyed it. "I just like to take it because I'm interested in it and I enjoy taking it. It's just fun, I guess. It's just like a big puzzle. You have to solve it. So, I like puzzles," he said. At another point in the interview he reiterated his feelings about math. "It's easy. It's like a jigsaw puzzle waiting to be solved. I like puzzles." Math, for Calvin, was something that "fit together." On the surface, this might indicate that Calvin felt math should make sense to him. However, a jigsaw puzzle is made from an image that was intact. After it has been cut apart, the task is to reassemble each of the small pieces in their previous order so the whole picture reappears. If this is a valid extension of Calvin's metaphor for the nature of mathematics, it suggests a very different view of mathematics from that promoted by mathematics education reformers in recent decades (e.g., Lampert, 1990; Fosnot & Dolk, 2001). Instead of receiving someone else's methods, procedures, and ideas in order to reassemble them in order to see a "picture" of mathematics that has previously existed for someone else, Fosnot and Dolk (2001), for example, envision mathematics in schools to reflect the construction of knowledge and the creative work of mathematicians:

> They make meaning in their world by setting up quantifiable and spatial relationships, by noticing patterns and transformations, by providing them as generalizations, and by searching for elegant solutions. They construct new mathematics to solve real problems or to explain or prove interesting patterns, relationships, or puzzles in mathematics itself. (p. 4).

When the work of mathematicians is the focus, the emphasis is on the activities of constructing, generating, and creating new ideas and explaining and justifying those ideas. Explaining a puzzle of mathematics is quite different from reassembling a jigsaw puzzle after gathering together all of the pieces.

It is possible that an unstated reason why Calvin enjoyed mathematics classes was because of the sense of certainty that came with replicating the teacher's solution process to get results that matched an answer key. Underlying much of Calvin's interview was a sense of uncertainty around other events in his life. In particular, his involvement in school athletic events was never certain and his plans for his future after high school had changed.

Calvin seemed to enjoy sports but he was not always able to make the team. He relayed, "At the beginning [of high school] I did baseball and basketball. And then the next year I didn't make baseball so I did track instead. I did basketball again and then last year I didn't make basketball at all. I just did track. I did cross-country last year, too. And then I did track and then last year I got a stress fracture so I couldn't do track. So I'm doing cross-country right now and then track in the spring." Although he faced obstacles, Calvin remained active in extra curricular activities.

Calvin also seemed uncertain when discussing his future career plans. He indicated he would have liked to be an engineer after high school, but was instead thinking of becoming a high school math teacher. He didn't have much confidence when discussing his abilities. "I kinda like helping people more often," he explained. "Because that's the only thing that I'm actually good at. I actually wanted to take engineering but I wasn't good at building anything so I choked on that. I actually like helping people understand how they apply it." As a result, Calvin had settled on being a high school mathematics teacher.

Calvin's decision to be a math teacher was due partly to the fact that, at the time of my interview with him, Pre-calculus was "probably" his favorite class. "That's the only thing I understand so far," he said. The traditional mathematics classroom at Cedar Valley High School seemed to be an environment where Calvin could gain confidence in his work. He was able to accurately reproduce the mathematical procedures (e.g., solving equations, factoring algebraic expressions) demonstrated by his teacher more quickly than his classmates so he viewed his performance in math class as one of his strengths. Still, the security of "right answers" was diminished by his lack of confidence in knowing if or when the answers were right. During the portion of the class when the teacher allowed the students to complete an assigned exercise set, Calvin would frequently check each of his results with other students or with an "answer key" at the front of the classroom that the teacher allowed the students to use. Neither Calvin nor his classmates appeared to have strategies for ascertaining the mathematical validity of their responses or, if they did, chose to call on the authority of the printed answer book. While Calvin's interview indicated his explicit reason for enrolling in advanced mathematics classes was because he liked them, an implicit reason may have been the appeal of a sense of certainty in mathematics that came from his experience in a traditional mathematics classroom.

Elizabeth: "I figured math would look good on transcripts."

Although Calvin enjoyed the mathematics classes, Elizabeth expressed no real interest in the subject matter and what she was learning. Instead, her primary objective for taking advanced mathematics classes seemed to be to increase her potential to continue her formal education beyond high school.

Like Calvin, Elizabeth was a senior at Cedar Valley High School. She had attended school in Cedar Valley since kindergarten. She had taken one more math class than Calvin. During her four years of high school, Elizabeth had completed five math classes, the most of any student at the school. In her freshman year she enrolled in Algebra I and followed that with Algebra II during her sophomore year of high school. As a junior she took both Geometry and Pre-calculus. She was one of four students in the Calculus class during her senior year. The math teacher had helped her plan her schedule when she started high school so she could get to calculus by her senior year. She followed that plan because, she said, "I figured it would look good on transcripts." This statement was representative of the main reason Elizabeth enrolled in so many math classes in high school: She felt they would better qualify her for admission to college and, subsequently, she would be able to get a good job.

Although she had completed numerous math classes, it was not enjoyment of the subject that motivated her to continue. She received good grades, and in reference to her calculus class, she was quick to point out, “I’m getting the highest grade in that class.” She didn’t object to Calculus, but her favorite class was College-prep English. “I really like to write,” she said. She also favored the English class “because I can be creative and basically reinvent myself in my writing.” It seemed important to Elizabeth that she have an avenue to express herself. She felt there was no chance for her to do that in the calculus class. After she had said English was a creative class, she was asked if calculus was a creative class. She responded, “If I were to use it [calculus] in a creative way. But, so far, it’s just work, tests, work, tests.”

This view was a clear reflection of the “traditional” structure of Calculus and all other mathematics classes at Cedar Valley High School. Both my observations and the students’ reports showed that each math class began with a time to correct answers to a previously assigned homework set. This was followed by a short explanation and worked examples from the teacher. An independent work time concluded the class when students began work on another homework set consisting of single-answered exercises usually from the textbook. Elizabeth’s response to her mathematics education is similar to that of students in similarly “traditional” mathematics classes reported in studies by Boaler (2000; Boaler & Greeno, 2000). Students in Boaler’s studies indicated displeasure with the monotony and lack of meaning in their “traditional” mathematics classes. Like Elizabeth, some also felt constrained and restricted when they could not express themselves and be creative in math classes.

In addition to feeling that mathematics did not encourage her creative potential, Elizabeth hinted that much of what she did in math did not really make sense to her. When comparing the Pre-calculus and Geometry she completed during her junior year, she said, “Geometry is more fun [because of] the art…. You get to actually make shapes that make sense.” As mentioned earlier, Calvin indicated he tried to fit together the pieces of the “math puzzle.” Since Elizabeth never expressed a real interest in math, she may not have even tried to make sense of the topics she was studying. She was concerned with getting good grades and having the courses on her transcripts. But a knowledge of the content of calculus or her other math classes did not figure prominently in her future. In fact, she said, "I don't think I'd need calculus to be a journalist."

Elizabeth was primarily motivated to study mathematics because, as she put it, "I figured it would look good on transcripts" when applying to colleges. "If you're wanting to go straight to a big university or college, you can't waste your time on home-ec classes or agricultural classes because they don't look for that on your transcript. They look for quality classes," she explained. Elizabeth hoped for a career as a journalist, "A journalist, or an editor or a publisher…. I'd like to be an editor of a magazine and I kind of want to do sort of a liberal, political magazine. And I want to focus on sexism mainly because it's one of the most interesting topics for me."

Elizabeth directly linked her decision to take advanced math classes in high school to her desire to go to college and have a career. Indirectly, she may have also linked her choices to her plans to live outside the rural community of Cedar Valley. She seemed to view herself as different from others in her community. She described her classmates in high school as "a bunch of rednecks." She went on to explain, "They have ultra-conservative views. They like hunting and they don't even consider whether things like that are wrong or moral. They don't even consider whether sexism or being homophobic is wrong. And all they think about is themselves generally." A similar theme continued when Elizabeth described the people in the community.

> Overall, a lot of them are really great people. They're really nice but they're close-minded. A lot of them aren't willing to accept that gay people exist, that logging might be closed down and that might be a problem for them. They're really nice but just don't

> understand that they're sort of old-fashioned. I think that really sets back the community. But with the amount of people going to college, I think that's changing.

For herself, Elizabeth hoped to move away from Cedar Valley and live in a larger city. "I like being close to cities where people – like college towns. I like college towns because the people are generally more open-minded there. And they're willing to accept you for who you are rather than criticize you." Turning again to her neighbors in Cedar Valley she said, "That's one of the major problems here. If you don't agree with someone's views then you're unpatriotic or you're a sinner or something. It's kind of old-fashioned." Elizabeth's stated reason for enrolling in advanced math classes was that they would better qualify her for college. But, it seemed, a reason she was determined to attend college was so that she could move away from Cedar Valley to a place where she thought she would meet people more like she saw herself. She considered a college education a part of being a more liberal, open-minded person.

In addition to her own desire for a career and a life outside Cedar Valley, her mother also seemed to have a strong influence on Elizabeth's decision to go to college. "My mom always told me I had to go to college," Elizabeth said. "Because she didn't go and she doesn't make very much money. And she told me that I needed to go to college if I wanted to have a good job." Elizabeth's mother was a single parent and worked as a meter reader in a nearby town. She had not finished high school. "I don't know what grade she dropped out, but she got her GED," Elizabeth explained. Elizabeth had her sights on college and a career in journalism. In fact, she laughingly confessed, "Having babies and taking care of a house never sounded great to me!"

Two aspects are prominent in Elizabeth's story. First, her purpose for studying advanced high school mathematics was because "it would look good on transcripts." She had no use for the mathematical knowledge itself. Second, Elizabeth seemed to use math classes as part of her plan to leave what she regarded as the “closed-minded” residents of the community, people with whom she didn’t identify.

Elizabeth was not wrong about taking elective advanced mathematics classes as preparation for college. In fact, it is widely regarded that a major function of mathematics has been that of gatekeeper to future opportunities (see, e.g., Moses & Cobb, 2001). Yet, it seems an unfulfilling reason for her to spend so much time devoted to an activity in which she doesn’t appear to enjoy. As “traditional” mathematics education plays out at Cedar Valley High School and countless other high schools across the United States (Stigler & Hiebert, 1999), it does not encourage and develop the creative potential in students’ thinking even though mathematics as a discipline is regarded as a creative (Boaler & Greeno, 2000).

Since enrolling in advanced mathematics classes is regarded as necessary preparation for college, it can serve as a prerequisite for rural high school students, like Elizabeth, not only for college but also for life outside their rural community. Of the 14 students I interviewed at Cedar Valley High School, Elizabeth was the most vocal in her negative characterization of the students and community residents. Her views came from her experiences growing up in the community and may have been influenced by her mother and other friends or family members. Other students also described the Cedar Valley community and its residents in stereotypically rural terms (e.g., rednecks, hicks), but they did so with more affection. It is likely easy for students like Elizabeth to choose to enroll in advanced math classes in high school because they led to college and a life outside the rural community.

But what about students who do not wish to go to college? Is there reason for them to enroll in advanced math classes? Students at Cedar Valley High School seemed to have difficulty providing an affirmative answer to this question when thinking of the mathematics education they experienced.

Benjamin: "Everything about computer is doing math."

Like Calvin and Elizabeth, Benjamin was also a senior at Cedar Valley High School. He had followed a course of study like Calvin, taking a math class during each year of high school: Algebra I, Algebra II, Geometry, and Pre-calculus. Benjamin was a very quiet student who had attended school in Cedar Valley from pre-school through the twelfth grade.

Benjamin planned to attend college and "go into computer science when I graduate." He was deciding between two different colleges, a private college in a small town about two hours away and a public university in a larger metropolitan area about one hour away that also offered courses at a nearby local community college. He seemed to have spent time investigating each option because he knew of the differences between the two programs and what each one emphasized. For himself, Benjamin was deciding between pursuing a program emphasizing the technical aspects of the computer and one more focused on programming. "I'm still deciding on the technician part – dealing with engineering, or deciding on programming. There's the programming of the computer and then there's the technician if you want to fix computers or want to make hardware for the computer," he explained. "I'm sort of learning towards the technician part. But I don't think it makes as much money," he laughed. He was aware the two programs would start with similar coursework and he could decide later which emphasis he would pursue.

Benjamin was more like Calvin than Elizabeth when he gave his reason for enrolling in Pre-calculus class, "Well, I like math." Then he added, "The teacher's great." Nearly all of the students indicated they felt Ms. Jones, the math teacher was CVHS, was supportive whether or not they enjoyed math and whether or not they enrolled in mathematics classes beyond the two courses required for graduation. When asked what he liked about math he replied, "Having problems to solve. Just getting a problem and figuring out how to get it done."

Each student articulated their own reasons for enrolling in advanced mathematics classes. Calvin enrolled in advanced math classes because he liked them and also considered a career in which he might build on that interest (e.g., engineering, teaching math). Elizabeth had no special interest in mathematics but took the advanced classes because they were expected for college admission. The predominant reason Benjamin enrolled in elective math courses was because he was interested in pursuing a career in computer science. Hence, he enrolled in a mathematics class each year of high school since "Everything about computer is doing math." I asked, "Do you think it's important to take math classes?" He responded, "I think it is for what I'm going into. Like, I don't know. If you were a logger you might need to know how big the tree is. But, like in computers you have to know every single math detail about what the program does. Most of it's numbers – all of the programs are based mostly on numbers." Benjamin's interest in computers left no question in his mind that he would not have taken the math courses. "If you're in computer, you have to do math. You'd have to know it before you get into it…. You'd have to learn it one way or the other." Benjamin saw a strong connection between what he was learning in the mathematics classes and its usefulness for working with computers.

Benjamin was possibly more knowledgeable than his classmates about college and the requirements for his career preparation since he had an older brother who was attending a university at the time of the interview. This gave him some insight into what was required of him as a student wishing to prepare for a career working with computers. As a result, Benjamin never doubted he would take math classes throughout high school. "Well, my brother took [Geometry and Pre-calculus] and most of my family's taken it. So it's what you need to go to college." As mentioned earlier, Benjamin believed math was also needed for studying computers in college.

Although Benjamin was confident that knowing and using math were a necessary part of a career working with computers, he seemed at a loss for a response when asked, "Do you know anybody who uses a lot of math in their work as an adult?" After a pause, he replied, "Math teachers, but I don't know about others. I'm not really sure." He said he had not considered majoring in math instead of computer science because, "I don't want to teach or anything like that. I'm not really a people person." Later, he said he wasn't sure what someone could even do with a math major if they weren't a math teacher.

Unlike Elizabeth, Benjamin enjoyed living in a rural area. He liked the small school, indicating the best thing about it was that "you know everybody. I think that is the best." As he considered his future, he wanted to continue living in a rural area: "I want to live in a rural area. I don't really want to be in a big city." He went on to mention he was comfortable with living in a rural area, but recognized that the availability of a job could influence his decision. "I've lived in rural areas most of the time. It depends on where the job is. If I get a job in a city, I'd probably commute to the city and live in a rural area." He explained his reasons for wanting to live in a rural area, "There are less people. It's peaceful. There's not as many cars. In a smaller area you can know quite a few community members. It's easier to drive to different places." Benjamin identifies a tension between having a job in a city and a desire to live in a rural area. Researchers have noted this tension in other studies of rural youth (e.g., Hektner, 1995; Howley, Harmon, & Leopold, 1996).

Benjamin's story illustrates that high school students sometimes study mathematics because it is related to their future career goals. For Benjamin this was a career working with computers. It also leaves unanswered the question, "What would someone do with a career in mathematics?" Calvin considered engineering but opted instead for teaching math. Benjamin could not imagine any career other than teaching mathematics for which a mathematics major was a logical qualification . This confusion could, in part, be a reflection of the occupations of the residents of Cedar Valley. Except for friends or family outside the community, students at CVHS were likely to know only one person who had majored in mathematics in college. She was their math teacher, Ms. Jones. It is likely that this would be the case in many rural communities where logging, farming, ranching, fishing, or mining are the historically dominant industries. Even in rural areas that have expanded their employment opportunities to include other industries, few residents would likely have studied mathematics as a university major.

Benjamin realized that pursing a career working with computers might take him away from his roots in a rural community. Still he had resolved the dilemma by imagining himself living in a rural area and commuting to work in a city. Would all rural students be able to see such a possibility? On one hand, might some students who wish to remain in rural areas not enroll in advanced mathematics courses in high school because they believe they would lead to careers that would take them away from the community? On the other hand, could the mathematics learned in high school lead to opportunities where students could contribute to the rural community in which they reside? Must mathematical knowledge be purely for export from rural communities? I conclude the paper by suggesting ways in which all students might be better served by their mathematical education.

DISCUSSION

The stories of the three students from Cedar Valley High School – Calvin, Elizabeth, and Benjamin – highlight some of the factors contributing to rural high school students' participation in advanced mathematics classes. Returning to the question addressed by these data – Why do rural high school students enroll in advanced mathematics classes? – the previously reported list of responses from students' survey responses (Table 1) are augmented with the interview data. What can be seen in these data is that, while some students, like Calvin, enrolled in advanced mathematics classes because they liked mathematics, math classes, or the teacher, they may have also enrolled because "traditional" school mathematics provides a sense of certainty not found in other disciplines. Other students, including Elizabeth, enrolled in the advanced mathematics classes because, in addition to preparation or entrance to college or work, they may have been looking to a future away from the rural community of their home. Finally, as Elizabeth and Benjamin indicated, teachers and family members can provide encouragement for students to enroll in mathematics classes after they have met minimum requirements for graduation.

In light of NCTM's equity principle and the expectation for all students to study four years of mathematics in high school, we can ask: What is the purpose of studying advanced high school mathematics? The students' responses in this study indicated that many of them were enrolled in the courses because they believed they were necessary for college. While that is an expected result, the students seldom indicated the *content* of the mathematics classes (mathematical knowledge) was useful or necessary for them to learn, not even for academic success in college. Elizabeth, for example, had no interest in the mathematics content she was expected to learn nor did she see its relevance. Still, she had taken more mathematics classes than any other student in the school. Was this an appropriate use of her time? If students are to enroll in advanced mathematics classes it would seem appropriate or even logical that they have the sense they belong there intellectually, that the class is a scholarly home for them. It is troubling that any would not.

Each of the three modes of belonging (Wenger, 1998) discussed earlier suggests ways high school students' participation in advanced mathematics classes can be increased. First, students need to develop a sense of belonging through engagement in the classroom with the ideas of mathematics. Students need to not only belong physically to the classroom but also feel their ideas and contributions are accepted by the students and teacher. This requires changes to both content and pedagogy of a "traditional" mathematics classroom. To begin, the view of mathematics portrayed by the content studied must change from mathematics as a fixed collection of memorized facts and rote procedures to one recognizing the personally constructed nature of mathematics knowledge (Dossey, 1992). Whereas the content of an algebra class with the former view maintains a focus on algorithms and symbolic manipulation, an algebra class with the latter view involves the processes of "doing mathematics" – problem solving, generalizing, communicating, and representing (NCTM, 2000). This change is necessary to allow students to understand that mathematics is something that can belong to them and in their life. Also, mathematics pedagogy – the way mathematics is taught – must change from the teacher attempting to transmit mathematics knowledge to the students to an environment where the students are encouraged to develop their own strategies and meanings for mathematical situations. Students must have the sense that their ideas are accepted and valued in the mathematics class if they are to have a sense of belonging.

At present, mathematics is viewed in most U.S. mathematics classrooms as a fixed collection of facts and procedures, and the role of the teacher is to transmit mathematics knowledge to the students (Jacobs, et al., 2006; Stigler & Hiebert, 1999). This circumstance contrasts markedly with the recommendations of NCTM (2000). Several commercially available "*Standards*-based" curricula have been developed with the intent to change both the content and pedagogy of high school mathematics (see, e.g., Senk & Thompson, 2003). In many of these curricula, the content of mathematics reflects the mathematical activities that Bishop (1988) identified occurring in all cultures: counting, measuring, locating, designing, explaining, and playing. For example, students develop algebraic models that count populations or predict measurements of a geometric figure as the dimensions of the figure change. The validity of mathematical explanations are not based on the sole judgment of the teacher but from the principles and conventions of the discipline. Chazan (2000) and Humphreys (Boaler & Humphreys, 2005) are two teachers who have written of their attempts to create classrooms with content that was relevant to more students and a pedagogy that included more students.

Students like Elizabeth would likely develop a greater sense of belonging in a mathematics classroom where students worked with mathematical tasks that allowed them to develop their own strategies for solving mathematical problems and make sense of mathematical ideas (Boaler, 1997, 2000). There would be the opportunities for her to be creative and explain her thinking to others in the class. It may take the focus away from mathematics as something to "get on the transcript" to one where the mathematical ideas were related to aspects of her present or future life. But would these changes disadvantage students like Calvin who thrived in the perceived certainty of "traditional" mathematics? While he would no longer be able to check his answers with the authority of the teacher of the answer key, he may develop more confidence in himself. In his classroom he seemed to have no way to know the mathematical validity of his responses. If part of learning mathematics was to justify, reason, and explain solution strategies and results, it is quite possible he would gain more confidence in his own abilities.

Another concern is whether mathematics classrooms that values the processes of "doing mathematics" successfully serve all groups of students: those intending to go to college, those who will begin work after high school, and students wishing to pursue mathematics-intensive careers after high school. This may be a particular concern for rural high schools since there are fewer teachers and students so several different classes cannot be offered. Research shows that students enrolled in classes using "*Standards*-based" curriculum materials score as well as other students on standardized mathematics tests. Moreover, they are often better at mathematical justification, representation of mathematical ideas, and communicating their solutions (Senk & Thompson, 2003).

Additional recommendations arise when we turn to the second mode of belonging, imagination. The images most students had of themselves and mathematics were those of personal development – becoming more educated or challenged – or preparation for college. These images extended outside the classroom and show the way students were seeing themselves in relation to their lives outside the everyday activities of the classroom. Teachers, too, should go outside the classroom – both figuratively and literally – to help students understand the place of mathematics in broader contexts. With a teacher's support, students can have new images of mathematics and themselves that include the importance of the content of mathematics they are learning in the classroom. Students at Cedar Valley High School were able to identify instances in their lives and the lives of other community members where arithmetic, basic geometry, and financial mathematics were used. Most could not identify where or when the algebraic procedures they were learning in school would be useful outside the classroom. For example, Elizabeth did not believe the mathematics knowledge would be useful in her future and Benjamin suggested that mathematical knowledge was not important if he wasn't going to study and work with computers.

One way this could be accomplished is by having students work on community projects that require their mathematical expertise. At Cedar Valley High School, as may be the case in other rural areas, the students in the advanced mathematics classes were among the most mathematically knowledgeable residents in the community. There was significant potential for these students to contribute to their community by bringing their mathematical knowledge to address and solve problems important to the community. Frankenstein (1995) has incorporated social issues into her classes with urban students. A similar approach may connect mathematics with the world outside the classroom for students who would have otherwise not taken advanced mathematics classes.

A second way to show the relevance of mathematics knowledge in life outside the classroom may be to have working people discuss the ways in which they use mathematics – beyond arithmetic – in their work lives. By doing this, students develop new images of mathematics as it is used in the "real world." Due to the economic and occupational opportunities available in Cedar Valley, few residents had jobs that required formal training in college-level mathematics. Still, it is likely that mathematics was a part of many people's work. [See, e.g., Hoyles, Noss, & Pozzi (2001) and Smith (1999) for a description of the mathematics used by nurses and automobile factory workers, respectively.] Also, professionals from nearby communities may have had formal training in college mathematics and could visit the school. The mathematics of working people was neither obvious to the students nor connected to their mathematics learning in school. As Calvin and Benjamin both suggested, a career as a mathematics teacher was the only reason they believed anyone would study mathematics in college. Another student in the Pre-calculus class, Julia, said, “I’m trying to find a career that has to do with math. I think I like math more than I like kids. That doesn’t sound good, but I like math more than I like to deal with kids.” Yet, she could not think of any other career option for which she would study mathematics other than teaching. Without being informed of the possibilities of a career in mathematics, it is unlikely any of the students would pursue the subject if they didn’t want to be a teacher.

Finally, teachers can make the most of the fact that many students were intending to attend college and had consequently aligned themselves with others of like intentions by enrolling in advanced mathematics classes. If a student is intending to enroll in college after high school, she or he should be well aware of the requirements for college admission and the expectations of college mathematics classes. To help students understand these expectations, high schools can partner with nearby colleges or universities to administer mathematics placement tests to students during their junior year. This tactic provides students with feedback on their mathematics progress before it is too late to take steps to enroll in additional mathematics classes during the senior year if necessary.

CONCLUSION

In concluding, I suggest that rural high schools may have an advantage over their non-rural counterparts when it comes to making changes to the mathematics curriculum that would encourage all students to study mathematics each of the four years of high school. First, rural schools tend to be smaller than their non-rural counterparts and, as a result, have fewer teachers. Each mathematics teacher has a significant impact on the mathematics education of the students.

They can often make changes to the mathematics curriculum, course sequence, and classroom experience of students without involving several committees or levels of supervisors. There is typically less bureaucracy in a small, rural school (Nachtigal, 1992).

Second, when there are few mathematics teachers, such as Ms. Jones at Cedar Valley High School, they have significant contact with the students. Ms. Jones was the mathematics teacher for many students for three or four years. As a result of extended contact with the same teacher, she got to know the students and their individual abilities. Many teachers in larger high schools comment on the varied learning experiences the students had prior to the class and have to take time to assess them to find common ground to begin. Ms. Jones, however, would not have that problem and could possibly have more time in the year which could be devoted to a community project involving mathematics.

Third, rural schools may have an advantage in encouraging students to study mathematics during each of their four years of high school because there may be fewer elective courses for students to choose from (Barker, 1985). If mathematics teachers design a relevant and engaging mathematics curriculum students may be more apt to make that choice whether or not they intend to go to college.

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