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Teachers' Perceptions of Rural STEM Teaching: Implications for Rural Teacher Retention

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Rural school districts often struggle with attracting and retaining high-quality teachers, especially in science subject areas. However, little is known about STEM in-service teachers' lived experiences of rural teaching as they relate to retention. In this phenomenographical study, six rural in-service science teachers were interviewed regarding their perceptions of the benefits and challenges of teaching in rural schools in general, and teaching science subjects in particular. Community interactions, professional development, and rural school structures emerged as three key factors related to rural teacher retention. Participants viewed each of these factors as having both positive and negative aspects. Findings from this study confirm existing literature regarding rural teaching, in general, but provide additional insight into the complexities of rural science teaching, in particular. Implications for rural teacher preparation, recruitment, and retention are discussed.

Keywords: rural teacher retention; rural teacher attrition; science teaching; teacher attitudes; rural education.

This study addresses gaps in the recruitment and retention literature by examining the lived experiences of rural STEM teachers, including their perceptions of the benefits and challenges of rural teaching, with the overarching goal of understanding the factors related to their persistence in rural teaching in general, and rural STEM teaching in particular. As the prior research suggests, there is a great need for studies focused on the lived experiences of in-service rural teachers and, specifically, how their experiences might influence their decisions to persist in rural teaching. Also, because the consequences of rural teacher attrition are dire for rural STEM learning in particular, it is necessary to investigate the experiences of rural STEM teachers and examine whether or not their experiences and challenges are peculiar or similar to those reported by rural teachers in other studies. Thus, the current study investigated the following research questions:

What are the lived experiences of rural STEM teachers?

What do rural STEM teachers perceive as the benefits and challenges of rural STEM teaching?
How do rural STEM teachers' experiences relate to rural teacher retention?

How do rural STEM teachers' experiences compare to previously published reports of rural teaching, generally?

Rural Teacher Attrition and Retention

Teacher turnover, estimated to be 9% annually (National Center for Education Statistics [NCES], 2009), presents a major challenge for rural schools. Although some teachers originating from rural communities remain teaching in the same school for their entire careers, other teachers leave rural schools soon after beginning employment (Monk, 2007). Problems with rural teacher shortages are compounded in secondary areas of specialization including mathematics, science, and technology (Monk, 2007). Compared to schools in central cities, suburban areas, and large towns, schools in rural areas and small towns have greater difficulty filling vacancies, particularly in physical and computer science areas (NCES, 2006). Hence, rural school districts particularly struggle to attract and retain quality science and math teachers.

The negative consequences of rural teacher attrition cannot be overemphasized. Rural teacher attrition often results in schools staffed predominantly with relatively new and inexperienced teachers (Murphy & Angelski, 1997). Compared to teachers working in cities, suburban areas, and towns, rural teachers are more likely to be younger in age and less likely to have earned graduate degrees (NCES, 2009). Additionally, rural teacher attrition can have deleterious effects on the quality of

education in rural schools. Schools in rural areas and small towns are more likely to deal with vacancies by cancelling planned course offerings and assigning an administrator or counselor to teach those classes (NCES, 2006). This solution to rural teacher shortages presents dire consequences for rural science, technology, engineering, and mathematics (STEM) instruction in particular. Due to teacher shortages, teachers specializing in other fields are sometimes required to teach STEM courses even if they are underprepared and uncomfortable with teaching these subjects (Friedrichsen, Chval, & Tuescher, 2007). Ultimately, student science achievement suffers when there is a STEM teacher shortage and when the available teachers are under-qualified for the subjects they teach (National Commission on Teaching and America's Future, 2002).

These challenges, coupled with the requirement of the No Child Left Behind Act (2001) that each classroom have a teacher qualified in the subject matter being taught, has led to increased interest among rural school administrators in identifying and understanding the factors related to the attraction and retention of rural teachers, especially those qualified to teach multiple science subjects. However, despite the continued interest in best practices and effective strategies for recruiting and retaining rural teachers, there are notable gaps in the literature and research in this area. There is a paucity of research on the manner in which the experiences and perceptions of rural in-service teachers relate to their persistence in rural teaching. Most research in the area of teacher retention is focused on why teachers leave rural schools and has been conducted mainly with pre-service teachers, first year teachers, and administrators. For example, of all manuscripts published in this journal, *Rural Educator*, between the years 2000 and 2010, sixteen addressed issues related to rural teacher attraction and retention. Of these sixteen manuscripts, eleven focused (primarily or partially) on issues related to the training, preparation, experiences, and expectations of rural pre-service teachers and/or professional development programs to improve the retention of new or first year rural teachers (e.g., Barley, 2009; Harris, Holdman, & Clark, 2005; Lowery & Pace, 2001; Munsch & Boylan, 2008). Only four manuscripts examined the experiences and/or retention of in-service teachers (e.g., Huysman, 2008; Malloy & Allen, 2007; Ralph, 2002). Davis (2002), referring to the paucity of research a decade ago, called for in-service teacher-focused studies that engender "in-depth knowledge about factors related to within classroom, whole-school, community, and personal/family spheres of influence and their impact on teacher retention" (p.

50). Davis' call for in-depth study of rural teacher attrition, though made a decade ago, is still relevant today. Such in-depth knowledge may best be gained from qualitative studies of the lived experiences of rural teachers and their perceptions of the factors that have positive and negative influences on the retention of rural teachers.

Benefits and Challenges of Rural Teaching

The perceived benefits and challenges of rural teaching may help to shed light on the attrition and retention of rural STEM teachers. Extant research suggests that factors such as the preparation time required, relationship with the principal, and lifestyle of the rural community influence teacher attrition and retention (Murphy & Angelski, 1997). Further, it has been suggested that new teachers must be prepared for the challenges of rural teaching by both earning the necessary credentials and learning about the nature of working in rural communities (Barley, 2009). Indeed, a large part of the rural "way of life" is managing the social aspects of rural teaching, both within and outside of the school. To that end, Jazabkowski (2003) noted that a distinct characteristic of rural teaching is the intersection between life and work. Because rural communities tend to afford little privacy to teachers, teachers must find ways of "fitting into" these communities in order to be successful (Jazabkowski, 2003).

Social capital theory (Coleman, 1988) provides a useful framework for understanding the effects of rural social interactions on the retention of rural teachers. Social capital theory posits, among other things, that the strong social networks in rural communities work to facilitate as well as constrain behavior through multiple community members rewarding or sanctioning the behavior of other members. When community members meet each other's expectations, trustworthiness is created; by contrast, when some community members resist norms or obligations, poor reputations arise (Coleman, 1988). While Coleman's assertion would be true in any social setting, what is notable about rural communities is that the impact (positive or negative) is more acute than in a diffused, large school, urban setting.

The multiplex relations concept of social capital theory also helps explain the benefits and challenges of rural teaching. Multiplex relations refer to situations in which persons are linked in more than one context (Coleman, 1988). Resources like information or obligations from one relationship can be appropriated for use in other relationships (Coleman, 1988). In the rural teaching context, multiplex relations may manifest as teachers having

multiple relationships with their students (e.g., as a teacher, sports coach, friend's parent) and their students' parents.

In sum, social capital theory helps to explain how the strong ties in rural communities can pose both benefits and challenges. Teachers who are unfamiliar with rural community norms may be unprepared for contending with these dynamics, contributing to teacher attrition. Conversely, teachers who are comfortable in rural environments may understand how to best capitalize on the benefits of rural teaching, contributing to teacher retention.

Despite the consequences of attrition for rural STEM teaching, little is known about the experiences of rural STEM teachers and how their experiences might differ from the experiences of rural teachers in general. Most research conducted to date has examined rural teacher retention, broadly, with little attention to rural science teacher retention, specifically. Despite the national interest in enhanced STEM learning and teaching, especially in socioeconomically disadvantaged schools—including most rural schools—little is known about how the experiences of rural STEM teaching relate to rural STEM teacher attrition and retention. Most of the few studies (e.g., Aldous, 2008; Lake, 2008) addressing the retention of rural science teachers documented the experiences of rural teachers in other countries (e.g., Australia). We posit that the retention of rural STEM teachers in the United States may involve unique complexities related to community and school factors that have an impact on support for science teaching resources and pedagogical innovations. Hence, learning more about the benefits and challenges of rural STEM teaching is vital to developing strategies for increased retention of rural STEM teachers, and ultimately, students' science achievement and interest in science careers.

Study Design and Analysis

This study employed phenomenography to describe, analyze, and understand data regarding the lived experiences of rural STEM teachers. Phenomenography is a qualitative research framework which focuses on understanding perceptions of reality rather than understanding reality itself (Marton, 1981). The goal of phenomenography is to identify, describe, or make statements and assertions about participants' ideas and experiences (Marton, 1981). Although similar to phenomenology in its focus on lived experiences,

phenomenography differs in its emphasis on collective rather than individual meanings of experiences (Barnard, McCosker, & Gerber, 1999). Collective experiences are described using categories which are not specified a priori nor derived from preconceived ideas (Marton, 1981). When analyzing experiences of a certain group of participants, researchers using phenomenography specify categories that emerge from the data and may also calculate how many participants share these experiences (Marton, 1981). Phenomenography was deemed appropriate for this study because of our interest in examining the shared or collective experiences of our study participants as rural STEM teachers.

Participants

Participants were six in-service high school STEM teachers working in rural areas in Indiana. These participants were recruited from a group of seven in-service teachers involved in a summer professional development program designed to assist rural STEM teachers in delivering the global research topic of sustainable biofuel energy into their high school classrooms. All but one in-service teacher in the professional development program agreed to participate in a focus group interview session for this study, which took place prior to their participation in the two-week intensive workshop held in the summer of 2011.

Regarding participants' demographic characteristics, they were four female and two male Caucasian high school science and mathematics teachers. The teachers had taught a variety of STEM subjects including biology, earth science, chemistry, mathematics, physics, etc., in the school year preceding data collection for this study. The number of years they spent teaching in their current schools ranged from two to eleven. Two participants had experiences also teaching in urban schools, and four did not. All of the teachers had lived in their current communities for at least five years, most commonly more than 15 years. Regarding their communities of origin, all participants grew up on farms, in small cities or towns, or in the country. Four participants reported that they preferred to live in the country, one preferred to live in a small city or town, and one had no preference. Table 1 further describes the participants' demographic, professional, and residential characteristics.

Table 1
Participants' Characteristics

Descriptions of Participants (N = 6)	Frequency
Subjects Taught in Past Year	
<i>Biology</i>	4
<i>Earth science</i>	2
<i>Chemistry</i>	1
<i>Mathematics</i>	1
<i>Physics</i>	2
<i>Other subjects</i>	3
Years Spent Teaching in Current School*	
<i>2 years</i>	1
<i>5 years</i>	1
<i>8 years</i>	1
<i>11 years</i>	1
Years Spent Living in Current Community	
<i>5-9 years</i>	1
<i>10-15 years</i>	2
<i>More than 15 years</i>	3
Communities of Origin	
<i>On a farm</i>	1
<i>In the country (not a farm)</i>	1
<i>In a small city/town</i>	4
Preferences for Communities of Employment	
<i>In the country (not a farm)</i>	1
<i>In a small city/town</i>	3
<i>No preference</i>	2

Note. * = Information regarding this item was unavailable for two participants

Procedures

The focus group session solicited information about participants' experiences of teaching in rural schools. The interview protocol included questions

regarding teachers' experiences and perceptions of the benefits and challenges of teaching in rural contexts in general and teaching STEM subjects in particular. The interview protocol also probed teachers' perceptions of the factors related to rural

teacher attrition and retention. The session lasted 75 minutes, was audio-taped, and was transcribed verbatim for analysis.

Data Analysis

To accomplish the goals of phenomenographical methodology, the interview was analyzed using conventional content analysis to generate categories of perceptions reported by the teachers. Content analysis involves subjectively interpreting text by classifying, coding, and identifying themes (Hsieh & Shannon, 2005). An inductive approach to data analysis was employed, such that no preconceived theories were imposed on the data; rather, the authors attended to the themes that emerged from the data. Consistent with conventional content analysis recommendations, words, sentences, paragraphs, and comments in the focus group session transcript were the units of analysis (Stemler, 2001). However, where appropriate, the number of participants who agreed with the category described is also presented.

The researchers used the method of open-coding to identify statements/comments related to rural teacher attrition and retention. This process yielded 116 total statements or phrases reflecting a variety of beliefs held by the six participants. Using the process of constant comparison, the 116 statements were categorized by grouping together similar statements and phrases into themes. Categories were examined in relation to each other, resulting in a hierarchical structure. To add trustworthiness to the data, a researcher not directly involved in data analysis reviewed the transcripts and analysis. The researchers reached a consensus about the codes and themes, and collaborated to reduce the data into the final categories.

Results

Analysis of the data revealed three broad themes or factors related to the attrition and retention of rural teachers: (a) strong interpersonal relationships and community ties in rural communities, (b) school factors, and (c) professional factors. Interestingly, teachers described each category as a set of double-edged factors consisting of both beneficial and challenging aspects. Teachers viewed the positive aspects as benefits of rural teaching and thus, factors that influence teachers' attraction and retention in rural schools. Conversely, teachers viewed the challenging aspects as factors contributing to the

attrition of rural teachers. These three themes and the associated categories are presented in Table 2.

Strong Interpersonal Relationships and Community Ties

This theme describes the benefits and challenges of the close relationships and strong community ties that exist in rural communities. Thirty-one of the teachers' comments (27 %) were related to community ties, of which twenty referenced the positive aspects and sixteen referenced the negative aspects. With regards to the positive aspects, teachers reported that rural communities are characterized by strong social connections and interactions, e.g., strong parent-teacher and student-teacher linkages that enhance their rural teaching experiences. Fifteen comments described how teacher-parent interactions and connections, coupled with the mutual trust that exists in rural communities, enhance not only community wellbeing, but also student learning and educational outcomes. For example, one teacher described how the partnerships she has cultivated enable her to invite knowledgeable community members into her classroom to discuss agriculture, a topic relevant to both science and rural life. She said:

I am able to form partnerships within the community...because of the people that I know...I bring agriculture into my lessons almost on a daily basis....and so the partnerships that we form maybe deal with just someone coming in and speaking, or it may be because a conservation officer has passed me on the street, and I say, hey, why don't you come in and speak to my kids?

The comments in this category indicate that community members and rural STEM teachers can work together to improve student learning and interest in science. With specific regards to teacher-parent connections in rural communities, a teacher mentioned that teachers often play multiple roles in rural communities and thus develop different types of relationships with the parents of their students:

We can make contact with the parents more easily, and it's more personal contact, because we've either been there long enough and we've had them in school, and they know us as a teacher, or they think of us as a teacher, or maybe our children have been in sports with...their children, or we've seen them in the community so we've had contact in a different type of way, other than just their child's teacher.

Table 2*Categories of Perceptions of Rural STEM Teachers Regarding Factors that Impact Attrition and Retention*

Categories			F
Strong interpersonal relationships and community ties	Positive aspects	Teacher-parent connections and mutual trust	15
		Sense of reward	5
	Negative aspects	Developing connections as an “outsider”	8
		Maintaining boundaries	4
		Challenging public relations	6
School factors	Positive aspects	Contact between teachers and administrators	4
		Personal interactions with students	13
		Safe school environments	3
	Negative aspects	Resistance to change	6
		Rural student performance	8
		Problems with administrators	5
		Salaries and benefits	10
Professional factors	Positive aspects	Intellectual stimulation	9
		Connecting science and rural life	6
		Opportunities for professional development	10
		Satisfaction and job security	4
	Negative aspects	Insufficient mentoring	6
		Preparing for multiple classes	3
		Lack of access to university resources	6

Note. F = frequency of comments. Total number of comments = 116.

Furthermore, five comments indicate that teachers perceived that the shared sense of belonging that characterizes rural communities makes rural teaching rewarding and enhances teachers’ interest, persistence, and commitment to rural teaching.

Examples of their comments were:

Feeling like you’re making a difference...we could go off and work in industry or work in, you know, research...but would we make the difference that we’re making in the smaller classroom with these students in this community?

Feeling like you’re contributing to a community.

Even if you’re an outsider, you can still get the community behind you over time, and then it makes it more rewarding, and you can bring those community aspects in there and you have those connections and that closer bond with the people there...that you would have to, if you went somewhere else, rebuild or try and build up.

Although teachers highlighted the advantages of the strong connections in rural communities, they also mentioned the associated challenges that could discourage their persistence in rural teaching. Specifically, three categories of the negative effects of strong community ties emerged from the data.

First, eight comments mentioned difficulties with being considered an “outsider” and the challenges of developing connections within tight-knit rural communities when teachers are new or live outside of the communities in which they work. Describing what it is like for her to live outside of her current school district of employment, a teacher stated.

The community there is very tight knit. [If] you live outside of it, trying to get into that community is awfully hard...because the rural communities are so tight-knit. And if you don't have kids that go there, or you didn't grow up there, you don't have that connection.

Second, teachers mentioned boundary concerns. Although they reported that living and working in the same community seems to help to build relationships and trust, teachers also mentioned that it often leads to fluid boundaries between work and personal life. Four comments referred to the challenge of having to always be “on call.” For example, a teacher said:

It's a small community, they know you, they know your phone number, [and] they know where you live. So, you know, you just usually get used to it, eventually, or they will just walk into your classroom, no matter [if] your door is open. You're basically on call 24 hours a day, seven days a week.

Teachers also noted another negative result of fluid boundaries: limited privacy due to community member awareness of their whereabouts and life circumstances. For example, one teacher said, “Your attendance, or whether you're there, what's going on in your personal life, whether it has anything to do with the classroom, is always out there.”

Third, six comments identified challenging public relations and their effects on teachers' reputations as another negative consequence of the strong interpersonal relationships that exist in rural communities. For example, a teacher stated:

If a student suddenly doesn't do well in your class, or if you have a bad experience with them, then it's not just an isolated event...then you're probably going to have that student again in the future, you're going to have siblings, and people in the community are going to talk, and then if somebody else has a bad experience, you're suddenly a really bad person, and so reputations can be formed and destroyed quickly...So you do have to be very careful in how you deal with parents and with the students.

With regards to rural STEM teaching in particular, participants did not make any comments that suggest that the identified negative and positive sides of the social connectedness in rural communities have any peculiar implications for rural science teaching, including the retention of rural

STEM teachers. Although some teachers indicated that community members and rural STEM teachers can work together to improve science learning (as earlier stated), the data suggest that the social factors encompassed by this theme impact teachers regardless of their expertise or the subjects they teach.

School Factors

Overall, 46 comments (40%) referenced school related factors that may influence the retention of rural teachers. Twenty-three of the 46 comments referenced the positive school environment in rural districts and the benefits of rural school structures including availability of teaching resources, safety, contact between teachers and administrators, and flexibility within the school. In most cases, participants discussed the impacts of these factors not only on rural teaching in general, but rural STEM teaching in particular.

Specifically, three categories of benefits of rural school structures and environment emerged from the data: (a) close relationships and contact among teachers and between teachers and administrators, (b) strong personal interactions with students, and (c) safe rural school environments. Four comments referred to the close relationships and contact among teachers and between teachers and administrators of rural schools as an important catalyst for rural teacher retention. Participants indicated that these close relationships allow for a more flexible science curriculum and school environment. For example, participants reported that they (as rural STEM teachers) have some leeway in taking students outside of the classroom, bringing in guest speakers, and incorporating other less conventional science teaching activities that help students see the relevance of science and promote student interest in science and science careers. For example, one teacher said.

The administration, because there's fewer teachers, because they know each of us maybe a little bit better [than they would in urban schools], there's a little more license yet they trust [us] ...If I say, well I want to walk over to the forest today, and we're going to need a little extra time, they know what's going on in my classroom, and so they know my students, they know me...So the smaller schools offer more flexibility, and more trust, I think.

Teachers identified this leeway as an offshoot of the structure and staffing model of rural schools including small class sizes and multiple-subject teaching assignments. Teachers indicated that this environment promotes positive teacher-student interactions, the second sub-category of benefits that

emerged from the data. Thirteen comments referenced the strong personal interactions with students that result from small class sizes and the opportunity to teach the same students over the course of multiple years. Participants reported that these structures enhance their ability to get to know students better, understand each student's needs, and personalize each student's learning. For example, a teacher said.

There were students that I first had as 8th graders and I had almost every year until they were seniors. And so you can really grow with them and...get to know them and help them develop better than, you know, just having them for one year or something like that.

For these teachers, prolonged student-teacher interactions and the opportunities to witness and be a part of students' cognitive and social development enhance their persistence in rural STEM teaching.

The third category was comprised of comments related to the benefits associated with safe rural school environments. Three comments indicated that participants feel comfortable and safe in their schools, partly due to the fact that rural students are generally well-behaved and partly due to strong connections among teachers, students, parents, and administrators. An example of the comments was:

I think the student body...they're more aware of each other, and they pick up on when some students maybe are not acting as they normally would...the teachers, we know each other, the students know each other, and then...you add those two layers together, and I just think it makes for a much more aware environment.

Turning to the challenges associated with rural school factors perceived by the participants, twenty-three comments discussed the negative sides of rural school teaching and staffing structures, environment, and administration; these comments yielded four categories: (a) rigid school structures and resistance to change, (b) poor student performance, (c) problems with school administrators, and (d) dissatisfaction with teacher salaries and benefits.

With regards to rigid school structures, all six participants agreed with the sentiment that it is often difficult to bring new or innovative science teaching approaches into rural schools. Although teachers reported having leeway necessary for curricular flexibility, they also noted that rural school structures often produce resistance to change. For example, a teacher discussed the difficulties she faced when she tried to incorporate an investigative type of learning in her classroom. She said.

[Investigative learning] was different than what the kids were used to, and it was a difficult thing for some parents to accept because...all of a

sudden, grades went from As to not As, Cs, and of course it was all my fault because their child always got an A until they got me. So, you know, that can be challenging sometimes, and to try to explain that...we're trying to teach more than just algorithms here, we're trying to teach a way of thinking, and that was not always well-received.

Second, eight comments referred to how the poor school performance of rural students may be a source of discouragement for teachers. Specifically, participants noted that in rural schools, where there are fewer high-performing students, it is often a challenge to get students motivated and interested in school and in STEM subjects. A teacher compared the performance of rural and urban students as follows:

If you can get into a larger school district, an affluent school district, where the students are going to be more consistently high performing, there's an attraction there for some teachers. Because...with the rural students, trying to get them to perform at the level they need to be performing at can be a real challenge; sometimes[school] holds no interest for [the students].

Teachers also noted the challenges associated with modifying their STEM teaching to account for the underperforming students. Three comments referred to the challenges rural STEM teachers face in their attempts to differentiate their instruction to accommodate multiple ability levels in one classroom. One teacher said.

The number of top students that you have is going to be different if you're in a larger school...I could have two AP classes that are full of top-notch students, you know, 40 kids, 50 kids. But at a rural school, if I still have those two classes, I'm going to have the whole range, from students that are barely capable, to maybe one or two of those top students. It's just quantity, you just don't have the numbers, and so if you want to offer those high-level classes, your trade-off is you have to understand you're going to have kids in there who maybe aren't going to perform as high...and you might have to bring your teaching down a level, still trying to challenge those one or two kids.

Although these teachers enjoyed the intellectual stimulation of teaching multiple science subjects at various levels, they also reported that they often have to devote a significant amount of time to class preparation in order to find ways to present their materials in a manner appropriate for students of varying ability levels.

The third category of challenging school factors identified by the teachers was problems with school administrators. Five comments referred to the politics and accountability issues that prevail in rural school districts. Regarding politics, one teacher mentioned the “politics and personal power plays” that occur in her school. Referring to how she interacts with her school’s principal, she stated, “I do my best to stay on her good side, but I know of teachers that...because of one reason or another...don’t end up on her good side, and they end up, you know, retiring, or they get the worst assignments.” In the same vein, the participants also discussed the downsides of administrator oversight. While some comments indicated that in rural schools, there is more accountability due to closer relationships with administrators, other comments indicated that because of the level of trust, there is little oversight. For example, one teacher offered the following description of oversight in her small rural school:

Our principal, he'll will go through the motions, he'll show up when it's time for an evaluation, but I think he goes more on word of mouth for his evaluations, because it is small, he can just go on what's coming in from the community, what he hears, and he may pop in if he's heard questionable stuff just to check it out...but that's about it...as long as nobody's getting hurt, nothing's really causing [worry] out there to have them check on you, they're not going to come in either... [This] is because of that trust part, I think.

The fourth category comprised participants’ perceptions of rural teachers’ salaries and benefits. Participants indicated that they feel they are underpaid. Ten comments referenced participants’ belief that poor compensation of rural STEM teachers contributes to attrition. For example, one teacher articulated her frustration that despite having numerous responsibilities as one of the very few STEM teachers in her school, she felt that her work was not valued. She said:

It's like we can give and give and give of ourselves to such a great extent, but yet, it's not valued. We never give enough, and it's not paid for...If it was being valued, at least in some respects, you can manage to do with less pay if you get an intrinsic value out of it, which I do, but, you know, there comes a point you feel like you're just being taken advantage of.

These teachers reported that rural teachers always need to find intrinsic reward in teaching, or they would not be able to work so hard with so little pay. A participant illuminated this point when she stated, “If you don’t find that personal reward, then teaching’s not the place for you. You know, you have

to be intrinsically motivated...it’s a mission field.”

Professional Factors

Overall, thirty-nine comments (34%) referenced professional factors of which twenty-eight referred to the professional benefits of rural teaching and fifteen focused on the associated challenges. Teachers’ discussion of professional factors focused more on rural STEM teaching in particular than rural teaching in general.

Twenty-eight comments referenced the professional benefits of teaching STEM subjects in rural schools, yielding four categories of professional benefits: (a) opportunities to teach intellectually stimulating science subjects, (b) opportunities to connect science topics to rural life, (c) opportunities for professional development, and (d) sense of satisfaction and job security. The first sub-category encompassed nine comments referencing opportunities to teach intellectually stimulating science subjects. Although some teacher comments referenced the heavier workload involved in teaching multiple science subjects, relatively more comments referenced its positive aspects. Participants seemed to prefer teaching varied subjects, as opposed to teaching the same subject all day. For example, a teacher compared her previous urban teaching experience to their current rural teaching experience:

The school where I taught for 12 years was a larger school, and even though I was trained and certified to teach AP courses, in 12 years, I only had a few opportunities to teach that. Now, at the small school where I'm at, I get to teach two different AP courses and...I wouldn't have had those opportunities to teach those other classes at a larger school where you might have a larger teaching staff and somebody latches onto those classes and never lets go of them.

Participants also mentioned enjoying the intellectual stimulation associated with teaching multiple subjects for different student ability levels.

The second category consists of six comments regarding participants’ perceptions that the geographic environment of rural communities provides science teachers with various opportunities to connect STEM subjects to rural life. Participants reported that rural communities offer excellent opportunities for linking science to rural life (in particular, farming and agriculture) and opportunities for experiential or hands-on science learning. For example, a participant mentioned the opportunities to use concepts related to wind energy and the wind turbines located on farms in rural communities to explain mathematical concepts to rural students.

Ten miles down the road, we are surrounded by farm fields or the windmill farms, or the wind turbines. I mean, my kids see that all the time, and trying to make connections for them besides just all the algorithms that they do, just show that there is meaning and purpose in our immediate area.

Another teacher discussed taking her students to dairy farms and corn fields to illustrate science, math, and technology concepts.

I have a lot of students who are from farming families... So we were able to you know, bring that into the classroom, talk about ...what happens at your farm... where you grow corn primarily and so...with the science and math and technology, I think we can make it more real for the kids, because we can actually take it out into the field and say, look, here it is.

Thus, for these teachers, the opportunities to employ inquiry-based and hands-on activities to make science relevant to students are important professional factors that contribute to their persistence in rural STEM teaching.

The third category of professional gains cited by participants was the ample opportunities for professional development, to which ten comments referred. Contrary to the general perception that rural teachers have limited access to professional development opportunities and resources, participants discussed the ease with which they could access these resources. Participants opined that access to professional development opportunities is easier for rural teachers than for urban teachers. For example, one teacher compared her experience going from a rural to an urban school as follows:

[Working in a rural school] I wanted to go to everything and do as much as I could to make myself a better teacher, and it was always welcomed, and I could go to everything, because nobody [else] wanted to go to everything. They're like, if you want to go to that, fine, we'll send you. But then when I went to my bigger school, with a much larger staff...the financial resources aren't the same, and so you are a bit more limited as to what you're able to attend, and a lot of the cost burden is placed...on ourselves.

Participants also mentioned that there are special professional development opportunities tailored to rural teachers, including the opportunities to secure grants to help implement new programs in their classrooms. Teachers' comments included

I've recently found a ton of advantages for professional development, [Particular Program] being one...This summer I'm in two others because of being from a rural school and

teaching in these areas...There's a lot of stuff out there that you can use and bring back to your classroom.

The fourth category of professional gains mentioned by the teachers included the rewarding aspects of teaching and a sense of job security. Four comments referred to the professional and personal gratification that comes from their contributions to the educational achievement of rural students and the wellbeing of rural communities including the feelings that they are making a difference in the community, witnessing students have "aha moments" and having a strong impact on students' success. For example, one teacher said, "The aha moments...the, 'I got it.' That's my favorite part." With regards to job security, four of the six participants agreed that job security was a positive professional benefit that contributes to the retention of rural STEM teachers. Not only did the teachers find their work in rural schools to be professionally gratifying and enriching, they also derived comfort in knowing that their positions were stable. When asked why STEM teachers stay in rural schools, one teacher said, "Job security. In [big cities], there's a hat with, you know, 1,000 names in it, and if you're gone, you're gone. But you know, I'm the only physics teacher at this school."

The professional benefits notwithstanding, teachers also talked about the professional challenges that could inhibit their persistence in rural teaching. Largely, teachers' discussions of professional challenges focused specifically on perceived hindrances to their professional growth, especially with regards to rural STEM teaching. Overall, fifteen comments referenced factors related to barriers to professional growth, yielding three sub-categories: (a) insufficient vertical and horizontal mentoring, (b) challenges associated with having to learn new material for multiple courses, and (c) lack of connection to university resources.

With regards to insufficient vertical and horizontal mentoring, six comments referenced the lack of guidance provided to new rural STEM teachers and the limited opportunities to collaborate with other STEM teachers in rural schools. Teachers noted that despite the vast array of professional development opportunities available to rural STEM teachers, they are often faced with barriers related to insufficient vertical and horizontal professional mentoring, including insufficient opportunities for peer-peer interactions and collaborations. For example, a teacher spoke of the difficulties of teaching on an emergency license with little prior preparation or guidance.

My first year, they actually called me, the principal at that school knew I was finishing up,

so...I hadn't student taught, I hadn't taken a methods class, I just got an emergency license, and so, and it was a week before classes started. So, you know, it was baptism by fire, it really was. I needed to talk to people...and I just really needed a sounding board, and I didn't get that.

Participants reported that even teachers who are not new to teaching often need “sounding boards” as well. For example, another teacher stated, “It’s hard to bounce off ideas, like say you’re thinking of doing something in the class, and you want somebody else to see how they think that would go...you don’t have that if you’re the only one in your area.

The second category was comprised of three comments indicating the challenges associated with having to learn new material for multiple courses or having to teach courses on a rotating basis. While teachers recognized that having diverse science teaching responsibilities can be intellectually stimulating for them, they also complained that it can become time-consuming. For example, a teacher talked about teaching something new every year. She described the experience by saying, “About the time you get your groove going, it’s time to quit.” Another teacher added that having multiple teaching responsibilities can be difficult, especially for teachers with many family responsibilities, as well. She stated, “Especially young teachers with young families, in a rural school, I would see where it would be very difficult to try and manage all the different preps, and raising a young family.”

The third category of barriers to professional growth that emerged from the data was lack of connection to university resources. The teachers reported that the geographic isolation of many rural communities often results in limited access to curricular and research support and resources from universities, and lack of connection to university researchers. Specifically, six comments referred to the relative disadvantage of participants’ school districts in terms of access to special programs, equipment, and other resources offered by universities. For example, one teacher noted, “Some of the teachers from the larger schools have had special advantages over the teachers who come from smaller schools, and it’s like, why can’t we have those advantages because we have less resources or less access to resources than some of these other teachers.”

Discussion

The current study uses qualitative data from a focus group session conducted to solicit information regarding six rural STEM teachers’ perceptions of the factors related to their persistence in rural teaching.

We believe that the findings can serve as groundwork for a holistic view of the experiences and persistence of rural in-service teachers in general and rural STEM teachers in particular.

Overall, the participants discussed the positive and negative aspects of three key factors influencing their persistence in rural teaching: community interactions, professional development, and rural school structures. Clearly, it would be an oversimplification to conclude that features of rural teaching fit neatly into categories of benefits and challenges. Rather, it is apparent that in several instances, there are two sides to each of the identified factors. The data showed that the same factor often poses both benefits and challenges to rural teachers.

Perhaps most notably, the study revealed how the close interpersonal relationships and social connections found in rural communities and rural schools can enhance or inhibit persistence in rural teaching. Consistent with social capital theory (Coleman, 1988), our findings suggest that strong social networks in rural communities engendered a sense of trust but also threatened teachers’ reputations when their actions were inconsistent with community norms. Participants indicated that parents felt safe leaving their children with them, and allowed them to use some unconventional teaching strategies like taking students onto farms to see the relevance of science in their lives. On the other hand, several participants described the ripple effect of having a bad experience with one student impact their reputation in the larger community; in this situation, teachers indicated that they would likely have the student and/or their siblings and friends in future classes, and possibly contend with the community assuming that one bad experience makes them poor teachers.

Our results are also consistent with the concept of multiplex relations. Our findings indicate that rural STEM teachers play multiple roles in their communities such as neighbors, fellow parents, church members, etc. These multiplex relations enhance communication and interactions with students, parents, other teachers, administrators, and community members, thus enabling teachers to form partnerships and develop a sense of trust. On the other hand, our participants also indicated that because community members knew them outside of school, they were “basically on call 24 hours a day, seven days a week,” leaving little separation between personal and professional life. Thus, communication and obligations are two sides of the multiplex relations coin.

With regards to rural teaching in general, these findings are not significantly different from what has been documented in previous research studying rural

pre- and in-service teachers. Previously identified factors including course preparation time, relationships with administrators (Murphy & Angelski, 1997), and dynamics of living in rural communities including the intersection between life and work (Jazabkowski, 2003) were confirmed by our study. Also consistent with our findings, Jazabkowski (2003) suggested that support and collegiality within rural schools allow rural teachers to create environments conducive to risk-taking in implementing new teaching practices. We suggest that the opposite is equally true. Negative experiences, including lack of support and collegiality, will have long-lasting negative consequences. Thus, supportive school environments can help teachers to be creative and innovative—which are essential qualities for STEM teachers, in particular.

With regards to rural STEM teaching, specifically, the findings of this study provide insight into factors related to the persistence and attrition of rural STEM teachers. The strong influence of norms in rural communities has significant implications for science teaching. Because rural communities may become complacent with their methods of doing things and because they are often insulated from outside information, innovation can be stifled (Florida, Cushing, & Gates, 2002)—including new curricular and pedagogical ideas. Indeed, participants in our study encountered resistance when they sought to change their teaching practices for the benefit of their students. For example, one teacher mentioned the challenges of introducing investigative-type learning when students and their parents were used to more conventional approaches. Unfortunately, compared to suburban students, rural students' science and mathematics achievement is under par (NCES, 2007), and they could likely benefit from precisely the innovative teaching approaches that are met with such resistance (Lake, 2008).

Clearly, the social aspects of teaching STEM in rural schools are complex. Educators who are unfamiliar with rural community dynamics may be unprepared to navigate community relations, contributing to STEM teacher attrition.

Implications

The goal of this discussion is not to critique the rich social connections that exist in rural communities, but rather to further discuss their implications for rural teaching. Rural school administrators and communities may need to devise effective strategies for helping new teachers become connected to the community; for example, by introducing them to influential people who can serve

as resources. One participant mentioned that offering housing benefits, such as down-payment or rental assistance, could help immerse new teachers in the community. Moreover, all of our participants felt comfortable with working in rural schools due, in large part, to growing up in small towns or rural communities. Therefore, those whose life experiences have shaped realistic expectations for working in rural communities may be better prepared and have increased chances of retaining their teaching appointments. Yet even STEM teachers who have never lived in rural areas can be successful with enough intrinsic motivation and proper guidance on how to assimilate into the community.

Beyond the social factors described above, other challenging and beneficial aspects of rural STEM teaching point to factors related to attrition and retention. Numerous responsibilities such as teaching multiple courses to multiple ability levels, combined with insufficient mentoring, lack of administrative oversight, and insufficient pay, can understandably take a toll on rural STEM teachers. Offering rural STEM teachers more preparation time may help them to manage their multiple responsibilities. Regarding the challenge of insufficient mentoring, rural schools may need to offer networking opportunities with other rural districts in the county, thus allowing for collaboration that would otherwise be impossible with so few STEM teachers per rural school. Furthermore, our results indicate that low salaries create not only financial stress to rural STEM teachers, but also give them the sense that they are not valued. Indeed, compared to their peers in towns, suburban areas, and cities, rural teachers earn less pay, even after accounting for differences in cost of living (NCES, 2007). Monk (2007) suggested that raising teacher salaries or offering benefits such as interest-free loans could help to solve the problem, but could be too costly for rural schools with no guarantee of effectiveness. Working to ameliorate the underlying concerns of rural STEM teaching, highlighting the benefits, and helping teachers to feel valued in other ways may be more plausible.

Indeed, our results suggest that there are many factors that could help to sustain rural STEM teachers in their teaching positions, including the job security inherent in working in rural schools with few STEM teachers, comfort and safety within rural school environments, and the personal gratification they derive from contributing to their communities and helping students to see the connections between science and rural life. Therefore, teacher educators are encouraged to explicitly train pre-service and in-service teachers in how to capitalize on the benefits and manage the challenges of teaching in rural communities. Ultimately, preparing creative,

innovative STEM teachers to implement relevant, experiential curricula in rural classrooms can have a tremendous impact on the educational attainment and STEM aspirations of our nation's rural youth.

Conclusions

This study used a phenomenographical framework to explore six rural high school STEM teachers' experiences of teaching STEM subjects in rural schools. Three major categories emerged: strong interpersonal relationships and community ties, school factors, and professional factors. Teachers discussed both positive and negative aspects in each of these categories. In many cases, the same factor emerged as both a benefit and a challenge, suggesting that some aspects of rural STEM teaching could be perceived as "double-edged swords." The positive aspects of rural STEM teaching help to explain rural STEM teacher retention, whereas the negative aspects help to explain teacher attrition. Therefore, multiple recommendations were made for rural school districts to help STEM teachers to capitalize on the benefits and manage the challenges of rural STEM teaching.

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- A limitation of this study is the small sample size consisting of six rural in-service teachers from Indiana. Indiana teachers may differ from teachers employed in other rural settings. Our participants were also unique in that they were all participating in a professional development program aimed at infusing advanced science topics into their high school STEM curricula. Therefore, compared to rural STEM teachers not participating in the program, our participants may have had greater access to professional development programs and special interests in using non-traditional approaches to rural science instruction, thus influencing their perceptions of rural STEM teaching. Hence, our results cannot be generalized beyond the scope and context of the study.
- Future research may examine rural STEM teachers' experiences using a larger, more diverse sample size. Additionally, researchers may use qualitative methodology to compare perceptions of current rural STEM teachers and former rural STEM teachers who decided to leave rural areas or the teaching profession as a whole. Such research efforts may contribute a different perspective of rural STEM teacher attrition and retention than was explored in our study.

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