**ABSTRACT**

Instructors at rural, two-year institutions have many insights that can inform biology instruction at other colleges to promote rural students’ success in the sciences. We present four principles, derived from three case studies of experienced rural instructors, to consider when teaching rural students. These include connecting to students’ lives, being attentive to their needs in and out of the classroom, having a rigorous curriculum, and providing expansive learning opportunities. These principles capitalize on the strengths of rural students rather than their shortcomings.

**Key Words:** rural education; assessment; college teaching.

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**Introduction**

In our current “post-truth” society, many people place little value on the use of scientific evidence in decision making, arguably one of the most important goals of science education (e.g., AAAS, 2011; Murakami et al., 2017). Students need skills for evaluating scientific data, as well as media literacy to sort through the onslaught of media. Even in the digital age, geography is an influential factor in determining educational opportunity, especially at the post-secondary level (Hillman, 2016). For instance, some studies show that rural students are less represented in science careers and have difficulty trusting and evaluating scientific sources of evidence, compared to their urban counterparts (NCES, 2014; Oliver & Hodges, 2014). If so, postsecondary education of rural students in the sciences is vital because it represents an opportunity to equip citizens and future leaders with greater scientific literacy.

In addition, researchers are beginning to recognize the value and strength of rural residents’ political and social viewpoints, as evidenced in the 2016 election cycle. Belkin (2017) describes how university communities were blindsided by the results of the presidential election because rural students are underrepresented on university campuses, labeling this a “rural reckoning.” The divide between rural and urban has increased (Byun et al., 2012), and some students are met with a very different culture on college campuses compared to their small, rural hometowns (Hillman, 2016; Belkin, 2017). However, many universities are now actively working to recruit rural students to their campuses in order to enhance the representation of their viewpoints, as well as to enhance science literacy and evidence-based attitudes through postsecondary education in the sciences. Yet despite this awareness of the cultural differences between university and rural populations, education research still fails to consider the unique backgrounds of rural students, except in a deficit view (Katsinas & Hardy, 2012). Thus, we focused our research on rural community colleges to provide an example of how experienced rural instructors use their students’ strengths to promote science learning.

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**Background**

Rural community colleges can be described in various ways, so it is important to clearly define rural when discussing rural-specific education research (Howley et al., 2014). For our purposes, a rural community college is a two-year college that has fewer than 2300 students enrolled at a single campus location, is located in a town with fewer than 50,000 residents, and is more than 30 minutes away from a metropolitan center of more than 50,000 residents.

Rural community college students have unique characteristics compared to their urban counterparts (Table 1). For instance, they might commute about 50 miles rather than live on campus (Hillman, 2016). Some rural students live...
in what Hillman (2016) terms “education deserts.” They lack any reasonable commutable choices for postsecondary education compared to their urban counterparts. For students of color, those who work full-time, and those who have children, the distance between college and home is a crucial factor in the college decision (Kim & Rury, 2011; Hillman, 2016). Rural students may also lack high-speed Internet, which can limit their use of online learning opportunities (Salemink et al., 2017). This limited mobility also represents a strength of rural students, in that staying near home allows them to have the support of their family and friends while attending college (Hlinka et al., 2015). Conversely, family and work commitments can often pull rural students away from their college studies (Hlinka et al., 2015).

Previous studies have established that the best support that instructors can provide for rural students, regardless of education level, is to foster a personal connection and relationship with them (Bers & Schuetz, 2014). These personal relationships can help students remain in school and complete their degrees. Improving student success is also important for the survival of rural communities, which can have difficulty recruiting qualified STEM employees such as nurses. Rural students represent a local STEM labor force that can add much economic value (Dowd, 2007) and emotional and financial support for future STEM students who live in the area (Hlinka et al., 2015). Hlinka and colleagues encourage community college instructors to consider building “confidence and skill sets necessary for our students to succeed in the broader world represented by the four-year university and beyond” (2015, p. 13).

Promoting the postsecondary education of rural students is uniquely challenging for instructors and institutions. Historically, rural students have been viewed as deficient because of their strong commitments to work and family, their lack of access to advanced science classes, and their socioeconomic background (Dowd, 2007; Byun et al., 2012; Hlinka et al., 2015; Hillman, 2016). We propose that educators change these views and capitalize on the strengths of their students by emulating the practices and beliefs of experienced biology instructors at rural community colleges (Hlinka et al., 2015). Here, we present four research-based principles to help instructors support rural students in postsecondary biology classrooms. We have named them the CARE Principles.

### Derivation of CARE Principles

Educators at local community colleges stand at the forefront of science education for rural students and are an important source of best practices. Rarely are community college instructors’ practices and beliefs studied except through broad survey methods, which fail to capture some important details. Thus, we used case study methodology to look in depth at three instructors’ beliefs and practices when teaching biology to rural community college students in the Midwest.

Over the course of a single semester, the first author (J.B.) followed these three experienced biology instructors (profiled in more detail in Table 2) into their science classrooms to observe their practices. Through semi-structured interviews, we documented their beliefs about teaching and learning. Detailed notes of the instructional strategies they had planned, as well as their actual practices, were collected. Additionally, we documented the students’ perspectives on the instructors’ actions. We have drawn on the education literature and our conclusions from this study to propose four principles for postsecondary educators to consider when teaching rural students in their biology courses.

### CARE Principles Explained

Overall, we derived four principles from this case study, summarized with the acronym “CARE.” Table 3 provides a definition of each principle, while Table 4 presents examples of these principles in practice. The principles emphasize that community college instructors should establish a relationship with each student to help support him or her throughout the college science education journey. For each of the four principles below, we provide an explanation of the

### Table 1. Characterizing rural community college students.

| Characteristic | Rural students typically . . . | Source |
|---------------|--------------------------------|--------|
| Family        | - Have strong family ties that can be both supportive and a hindrance. Fewer community resources result in fewer options for outside support of family members. - Have parents who value education and are more actively involved in their children’s schools than urban parents. | Bers & Schuetz, 2014; Hlinka et al., 2015 |
| Community     | - Stay near their home community upon degree completion, choosing a college within commuting distance. | Katsinas & Hardy, 2012 |
| Commuter      | - Have fewer college choices within a commutable distance than their urban counterparts. The average commute is 52 miles. - Travel farther than urban students to attend college. | Hillman, 2016; Burke et al., 2016 |
| K–12 education| - Have fewer resources and educational opportunities, due to weaker tax base for rural K–12 schools than for their suburban or urban counterparts. | Silverman, 2014 |
| Work          | - Are more likely to work full-time (41%) compared to their four-year student counterparts (23%). | NCES, 2017 |
principle, a brief review of the literature supporting the principle, and examples from the case study to illustrate the principle.

**C – Make connections with students’ lives and personal interests in and out of class**

Biology instructors can promote stronger relationships with their rural students by connecting the class content with students’ personal interests and establishing a relationship outside of the classroom (Fong & Siegel, 2005; Bers & Schuetz, 2014; Latz & Rediger, 2015). Within the class content, biology lends itself to connecting content with students’ lives. When the content is seen as important and understandable by students, students are more engaged (Hardré et al., 2009). Connecting assignments to authentic tasks, which allows students to experience science in everyday activities such as writing a letter, can promote students’ interest in the task and content (Nguyen & Siegel, 2015; Zielinski, 2017).

Our case study participants all carefully connected with students’ interests within the classroom. For instance, Richard, who taught a class for nursing students, often brought in health examples from his own life to illustrate content information. During observation, Richard connected content about viruses to a recent, local measles outbreak. Within the first 20 minutes of one lecture we observed, he also touched on how a home pregnancy test works, listed the vaccines he had received before taking a trip to Brazil, and recounted the story of a friend who had lung cancer. Richard’s students described him as a storyteller, whose stories helped them remember the content on exams. Jane taught the same nursing course at another campus. She often used examples from the students’ laboratory experiments to connect with the content. When discussing cell metabolism, she had students work together to list all the requirements of a cell, using the laboratory-cultured cells as an example.

Meg taught a nonmajors plant biology course. She realized that many of her students lived on farms, so she often incorporated agricultural examples into her lectures. Meg also knew that not all of her students were farmers, which led her to purposefully choose other examples she thought would be widely familiar to all students. These included ripening of bananas from a grocery store, human development, and growth of marigolds, to name a few. Meg described her reasoning behind this as “using real-life examples, trying to connect to stuff they would understand. Especially with science with the nonmajors, courses can get very techy, especially with terms, so you can lose students very easily.”

Outside of the classroom, these instructors tried to build relationships with their students. All three instructors served as advisors for the Phi Theta Kappa honor society at their respective schools. This allowed them to work more closely with students. Before and after class, all three instructors asked students about their personal lives, focusing on topics such as their family or work. They also talked with students about upcoming local community events. These examples demonstrate that all three of these experienced faculty took time to get to know their students on a more personal level outside of the course content. They did so to help foster a more caring science classroom.

**A – Be attentive to students’ needs in and out of the classroom**

The literature supports the principle that instructors who are attentive to meeting students’ needs are more successful instructors because they modify their instruction accordingly (Windshitl et al., 2012).

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**Table 2. Characteristics of participant instructors and their colleges.**

|          | Meg         | Jane        | Richard      |
|----------|-------------|-------------|--------------|
| School name (pseudonym) | Northbend | Southview | Eastside      |
| Type of campus          | Satellite  | Satellite  | Main         |
| College enrollment      | 180        | 600        | 2300         |
| Town size (population)  | 12,000     | 19,000     | 11,000       |
| Driving distance to nearest metropolitan area | 1 hour | 1 hour | 40 minutes |
| Years teaching          | 15         | 12         | 26           |
| College diversity       | 80% white  | 93% white  | 93% white    |
| Course observed for this study | Introductory Plant Biology | Microbiology for Allied Health | Microbiology for Allied Health |
| Number of students in course | 9         | 10         | 19           |

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**Table 3. CARE Principles.**

|   | To provide a caring and supportive environment for rural students, instructors should . . . |
|---|------------------------------------------------------------------------------------------|
| C | Make connections with students’ lives and personal interests in and out of class.         |
| A | Be attentive to students’ needs in and out of the classroom.                               |
| R | Provide a rigorous curriculum to promote student learning of content.                     |
| E | Design expansive learning experiences that challenge rural students to encounter different viewpoints and stances. |
This directly aligns with student-centered calls for reform of science teaching. Such reforms position teachers as guides to student discovery of content rather than as lecturers who speak about unconnected concepts (AAAS, 2011). Historically, community college faculty have relied heavily on traditional lecturing, which involved the instructor explaining the content directly to the students (Lei, 2007). Yet more recent studies point to an increase in student-centered practices (Zielinski, 2017). Previous comparison studies of community college instruction have found that instructors using student-centered instruction, rather than teacher-centered lecturing, were more satisfied with their teaching and that their students were less likely to drop the course (Lysne & Miller, 2015). Many instructors overlook that those who do not complete their degree often attribute their incomplete education to work and family needs (Bens & Schuetz, 2014). Instructors can help students navigate these demands on their time by being attentive to students’ needs in and out of the classroom.

We found that Meg and Jane practiced student-centered instruction in their classrooms. Although Richard noted that he would like to add in more group work and reduce lecturing, he did not feel he had the time to add these components because of all the content he had to cover. Jane’s practices challenge this view: she taught the same course with the same content goals, yet she kept her content goals and activities for the day adaptable, depending on student needs, and used group work. She used in-class assessments such as clicker questions to gauge student understanding. If she found that students did not understand the concept, she explained the concept again rather than continuing with the lecture. In the semester of study, Jane noted that her students successfully performed group work by sharing responsibility well, so she assigned and designed more group work activities.

In all the interviews, the students listed three main outside constraints on their time: commuting, work schedules, and family commitments. Jane showed attentiveness to students’ outside commitments in her course planning. First, Jane polled students to ask how far they commute to campus, which can be up to two hours one way. She described how knowing these commute times “colors things, like how hard I try to find someone to watch my sick kid for an hour.” Additionally, she described a previous semester in which students repeatedly failed to turn in homework. Rather than punishing students with a score of zero, she decided to stop assigning homework, “because they weren’t doing it, so it wasn’t helping them.”

Meg showed her care for her plant biology students when she responded to their needs by completely changing her instructional style mid-semester. She had found that her current group of students was not actively taking notes or looking up while she was lecturing. For her online lectures as part of the hybrid course, few of the students were watching the lectures, so she stopped recording them. Instead of lecturing, Meg had students print out the original slides and spend the class time working together in lab groups to complete learning activities. Student interviews strongly supported this change in instructional style. They noted that the hands-on

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Table 4. Alignment of CARE Principles with examples from rural biology instructors.

| Principle | Instructional Examples |
|-----------|------------------------|
| C Connective | Richard: Connected course content to health examples both local and personal.  
Meg: Connected course content to agricultural examples – apples ripening; connected course content to students’ everyday experiences – human development, bananas, marigolds.  
Jane: Connected course content to laboratory experiences – cell metabolism.  
All (outside of class): Phi Theta Kappa honor society mentor to students; discussed and took interest in students’ lives before and after class. |
| A Attentive | Jane: Adapted course activities regularly to meet students’ content needs; changed course assignments based on student interest, was aware of student commute times when considering class cancellation policies.  
Meg: Changed her instructional style to include less lecture and more hands-on activities to keep students engaged; carefully considered the connection of each assignment to learning objectives to eliminate busywork; justified purpose of out-of-class activities to students.  
Richard: Decreased page counts and requirements for the larger projects to guard students’ out-of-class time. |
| R Rigorous | Meg: Used multiple types of assessment to evaluate students’ strengths and weaknesses; designed activities to address their weaknesses; revised course content to focus less on math skills and more on understanding of the concepts (e.g., Hardy-Weinberg equation).  
Jane: Designed activities to expose students to difficult math concepts (logarithms) in several ways.  
Richard: Did not compromise on content standards and connected student effort to performance; designed laboratory activities to be complementary and supplementary to the lecture portion of the course to allow time for more content coverage. |
| E Expansive | Meg: Designed course activities that had students examine global use of plants; allowed for anonymous student questioning when teaching difficult content such as evolution.  
Jane: Connected course content to laboratory experiences  
Richard: Discussed vaccines needed for diseases more prevalent in countries outside the United States.  
Meg: Designed course activities that had students examine global use of plants; allowed for anonymous student questioning when teaching difficult content such as evolution.  
Jane: Connected course content to agricultural examples  
Richard: Discussed vaccines needed for diseases more prevalent in countries outside the United States.  
Meg: Designed course activities that had students examine global use of plants; allowed for anonymous student questioning when teaching difficult content such as evolution.  
Jane: Connected course content to agricultural examples  
Richard: Discussed vaccines needed for diseases more prevalent in countries outside the United States. |
activities helped them learn and kept their interest. Meg described her reasoning behind this adaptation: “I think that sometimes, when you have the more mechanical students, if you give them something to do, they are more engaged with it.” This change was also directly related to Meg's attentiveness to her students' outside commitments. One student in her plant biology course worked overnight before coming to class and would frequently fall asleep in class. Rather than call attention to her, Meg modified her instruction with less lecturing to help this student stay engaged with the content. Meg curated out-of-class assignments so that each had a clear purpose for learning, to avoid assigning busywork. She did not want to waste students' time on activities that did not directly meet the course’s learning objectives.

While Richard’s in-class activities were primarily teacher-centered, he did show attentiveness to his students' other commitments. He began to adapt his assignments to be shorter while still meeting his learning goals. For instance, he developed an activity in which students described 10 microorganisms, down from the 20 he had required previously. He also added a template for the microorganism list so that students just needed to fill in the required information, saving them time and helping them succeed. This allowed students more time to work on their other research paper about a disease-carrying organism, which he also shortened. Overall, the rural instructors took their students' backgrounds, outside commitments, and strengths into consideration when planning instructional activities to keep them engaged and motivated in their classrooms.

**R – Provide a rigorous curriculum to promote student learning of content**

Designing a rigorous curriculum goes beyond providing students with challenging activities or higher expectations of ability. According to Windschitl and Calabrese Barton (2016), rigor is “co-determined by standards of performance particular to a task, the quality of support offered by the teacher, and the intellectual activity engaged in by learners” (Windschitl & Calabrese Barton, 2016, p. 1101). Thus, rigorous experiences for students do not happen by chance, but rather are created through careful consideration of students’ abilities and understanding. Rigor in science education can be viewed as giving opportunities for students to test their ideas, understandings, and beliefs about science concepts through experimentation, writing, and group work (Windschitl & Calabrese Barton, 2016). We found that our instructors included a rigorous curriculum in various ways throughout their instruction.

Not only does the adaptability of Meg and Jane to students needs show their attentiveness, it also provides an example of rigor in their classrooms. Meg had to understand her students' backgrounds before she could include learning activities that challenged their understanding. Meg designed assessment activities that helped students learn content — such as the Hardy-Weinberg equation — that she knew represented a weakness for them based on previous assessments. Instead of challenging students with the mathematics, she redesigned her curriculum to allow students to interact more with the concepts:

I still teach Hardy-Weinberg, and I teach it pretty in-depth. But we come at it more as a violation of the assumptions, and how that then leads to evolution. . . . And I think they have a good understanding of it, and the math was just scaring them so much that they weren’t able to process the content.

Jane approached the importance of understanding the mathematics differently to ensure rigor in her classroom. Aware that her students likely had not encountered logarithmic growth before, she nevertheless thought that it was important for comprehending molecular biology. She described her approach: “I don’t make them take logarithms of anything ever, but knowing what it means and why it is significant would be helpful.” Jane’s instructional strategy involved exposing the students to concepts many times and in many ways through quizzes and activities in lecture and laboratory settings.

Finally, Richard was the instructor with the greatest expectations for his students. When describing his background as a former commuter student at a community college, he acknowledged the demands on his students but posited that effort is directly related to performance. He explained, “I’m gonna expect that you are a college student, that you are going to put in the hours just like everybody else.” Those hours included time in the laboratory, which he described as complementary and supplementary to the content given in lecture. This allowed him to cover more content material for his microbiology course than he would have covered if they had overlapped. For example, Richard did not cover mitosis and meiosis in the lecture portion of the class but reserved that information for laboratory experiments. He felt he could challenge students to encounter concepts better suited to the laboratory without using valuable lecture time. Although they demonstrated it in different ways, our three instructors each included a rigorous curriculum that took students’ current understandings and challenged them.

**E – Design expansive learning experiences that challenge rural students to encounter different viewpoints and stances**

The final principle might, at first glance, seem to contradict the principle of connecting to students’ personal lives. Nevertheless, rather than causing a disconnect, designing expansive learning opportunities provides rural students a chance to connect to the world outside of their small communities. When rural students attend their local community college, they often encounter students whose backgrounds and viewpoints are very similar to their own (Pini et al., 2015). Although this makes students more comfortable, it can also lead to disadvantages for rural students because there are fewer chances to grapple with viewpoints that challenge their own worldview (Howley et al., 2014; Corbett, 2016). Thus, instructors who care about their students encourage them to grow during college by providing expansive learning experiences.

Meg carefully considered her students’ backgrounds when designing learning opportunities for exploring the world outside their own community. She described an incident in her microbiology course that prompted her to add a global component to all her courses:

I showed a picture of the slums in India . . . And a student turned to me and honestly said, “Why don't they just move?” And they weren’t being facetious or rude; they just literally did not understand why those people didn’t just live somewhere else.

She designed a research paper that asked students to consider the uses of a common plant around the world. In another instance, when teaching evolution, she gave them time to grapple with the content, which could contradict their conservative religious views.
During the unit, Meg allowed students to submit anonymous questions for her to answer the next day in class. She has found this allows her shyer students to “think about it, even if they don’t accept it.” Thus, Meg carefully planned global learning opportunities to be attentive to students’ backgrounds, to be attentive to students’ needs in and out of the classroom, to include rigorous curricula, and to design expansive learning experiences. These principles draw on the strengths of rural students found in the literature, rather than treating their perspective as a disadvantage.

The strongest education principles are often those that can be addressed in training teachers to teach in rural contexts, rather than in urban contexts only. We agree that more professional needs to be shown in training teachers to teach in rural contexts, as Biddle and Azano (2016) suggest, more interest in teaching practices, beliefs, and decision making during curriculum planning are a starting point for instructors to reflect and assess their own teaching practices. Belkin (2017). Rural science education as social justice. Cultural Studies of Science Education, 12, 45–52.

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