

BECAUSE THEY CARE:
RURAL COMMUNITY COLLEGE INSTRUCTORS' BELIEFS AND PRACTICES

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DEDICATION

To Micah, Titus, Ezra and Phoebe: may you always know that big dreams are possible in life.

For my Nate: your faith in me always makes me want to be better every day

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ABSTRACT

Community college instructors are influential in the lives of rural students, and they have key insights on the education of those students. Studies are needed to identify ways to support these rural students, who represent an important source of political and socioeconomic diversity for their communities and when transferring to universities. This multiple manuscript dissertation examines the instructional and assessment beliefs and practices of three experienced rural community college instructors. Using multiple case study methods and grounded in the curriculum development model, I found that the rural instructors tended to use more student-centered instructional methods. They considered students' future careers, acted as an explainer and promoted group work. The instructors held various beliefs about the focus and adaptability of assessment which manifested in their use of reflection to inform future assessments and instruction. The results of this empirical research informed the derivation of four CARE principles to help instructors support rural students in post-secondary biology classrooms. This dissertation concludes that instructors and researchers need to reconsider the common characterization of rural students as deficient and instead capitalize on their strengths.

CHAPTER 1

“We view community college Biology Education Research (BER) as a tremendously exciting area for exploration with enormous potential to uncover unique perspectives on biology education and foster innovation that could enhance community college student success and assist in diversifying science, technology, engineering and mathematics programs.”

(BER Task force; Schinske et al., 2017, p10)

INTRODUCTION

Science education research is mostly silent about the practices and beliefs of rural community college instructors. This dissertation fills a gap in the education research field because it has great potential to increase student success as noted above in the quote from a biology education task force (Schinske et al., 2017). Over 30% of all college students attend a rural community college at some point in their post-secondary education, but often these colleges are overshadowed in the research by their urban counterparts because of their smaller size and isolated locations (Katsinas & Hardy, 2012). In a recent article in *The Wall Street Journal*, Belkin (2017) called the 2016 presidential election a “rural reckoning” that left universities questioning how to recruit and maintain these economically and politically diverse rural students. According to previous research, the key in rural student recruitment and retention might be creating personal connections between instructors and students (Bers & Schuetz, 2014). Rural community college instructors can provide important insights to future instructors by drawing on their experiences teaching rural students. This dissertation originally

grew out of my personal interest in improving education for rural students because of my background as a rural first-generation college student. Three key questions guided this dissertation:

1. What beliefs do rural community college instructors have about teaching biological sciences to rural students?
2. How do their beliefs about teaching rural students manifest in their instructional and assessment practices?
3. How can these beliefs and practices be emulated by other instructors within and outside of rural community college instruction to support these rural students?

This is a multiple manuscript style dissertation. Each of the three main chapters are written with a specific journal and audience in mind. In the following paragraphs, I provide a brief summary of each of the three manuscripts.

Chapter Two is an empirical examination of the instructional and assessment practices and beliefs of three experienced rural community college biology instructors. For this manuscript, beliefs were viewed through the lens of personal practical theories (PPTs) and the curriculum development model. PPTs represent a set of instructor beliefs that are derived from an instructor's experiences outside the classroom (personal) and within the classroom (practical) (Cornett, 1990). Most recently, community college instructors have been characterized, via broad survey methods, to have more student-centered instructional strategies. This includes decreased class time spent with the instructor lecturing students and more class time devoted to problem-solving and group work (Zielinski, 2017). Through multiple case study methodology, I investigated the types of overall practices used in rural community

college science classrooms. Then, I determined how or if the instructors considered the rural background of their students when planning, implementing or reflecting on these practices.

Chapter Two examined the following research questions:

1. What PPTs do participating community college science instructors have about teaching rural students?
2. How do these PPTs manifest in the instructional and assessment practices planned and used by participant instructors?

Chapter Three specifically addresses the use and planning of assessment by the same rural community college instructors. Assessment is important because it influences all parts of instruction (NRC, 2001). Previous studies have found contrasting assessment practices of community college instructors. Some instructors focus primarily on objective exams of content knowledge (Lei, 2008), while others are more likely to use research papers and projects to assess critical thinking (BoarerPitchford, 2014). This empirical manuscript follows the same three instructors to examine their beliefs and practices specific to assessment in their college biology classrooms. Chapter Three also uses multiple case study methodology to answer the following two research questions:

1. What personal practical assessment theories (PPATs) do participating community college instructors have when teaching an introductory biology course?
2. How do these PPATs manifest in the assessment practices of participating community college instructors?

Although this study does not directly focus on the effect of the rural context on instruction, it still lends important insights for community college instruction.

Chapter Four translates the findings from the previous two studies to a practitioner audience. It is aimed at helping instructors support rural students in their science classrooms. Informed by the two empirical studies, I sought to provide practical guidelines to instructors actively teaching or planning to teach rural students. Supported by a thorough examination of the research literature, I derived four principles that instructors should consider when designing courses with rural student success in mind. These principles were labeled “CARE” principles. CARE principles prompt instructors and professional developers to consider ways to develop a more personal, supportive relationship with their students. The culmination of this study is the presentation of these CARE principles, which seek to help others emulate the successes of the three experienced instructors studied in this dissertation.

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CHAPTER 2

Building on rural students' strengths: Beliefs and practices of experienced community college instructors

INTRODUCTION

Rural college students increasingly are the subject of stories in mainstream media and of studies by education researchers. Education of rural students is a growing concern because many U.S. residents place little value on scientific evidence, in part because of a political landscape that often questions or rejects science. College students with a rural background represent more than 30% of all students enrolled in formal post-secondary education (Katsinas & Hardy, 2012). They often live in relative geographic isolation from a major college or university, which restricts access to rigorous science education (Hillman, 2016). In the absence of education, rural students' views might be shaped by dubious news sources, friends and social media. In turn, these views could influence popular opinion and policymaking in ways that limit scientific research and innovation (Belkin, 2017). For example, the election of a president whose comments and actions often are at odds with the scientific community surprised academics at large research universities, according to a recent article in *The Wall Street Journal* by Belkin (2017). The academic leaders attributed the president's election in part to the disconnect that often exists between the larger post-secondary education system and rural residents. To address this gap, many universities are actively trying to recruit more rural students (Belkin, 2017). Historically, universities fulfilled their diversity requirements by recruiting and admitting urban minority students who satisfied school goals related to race and

socioeconomic status. But in general, most of those requirements have failed to include rural students who might be high achieving. Many rural students are white and come from low-income families, and they could help universities achieve greater political, economic and social diversity (Byun et al., 2012).

Rural students often choose to attend local, small community colleges because they are more affordable, closer to home and easier to schedule around. These rural community colleges serve as an important access point to post-secondary education for rural students, who are more likely than their urban counterparts to be the first generation to attend college and to be from a low-income background (Katsinas & Hardy, 2012). These colleges also play a role in rural communities by producing graduates who can enter the local science, technology, engineering and math (STEM) workforce. While rural students' backgrounds are often presented as a detriment to further education, some researchers are recognizing the benefits that rural students get from their community background such as family and community support (Hlinka, Mobelini & Glitner, 2015; Byun et al., 2012).

When students stay and work in the community where they earned their credentials, this enhances the local economy (Katsinas & Hardy, 2012). This is especially true in the case of nurses and other health professionals. Likewise, rural community colleges act as an important stepping stone for students considering a transfer to a university to complete a 4-year degree, a process that is often difficult as students assimilate to university culture (Bers & Scheutz, 2014). Most importantly, research in student retention has found that community college instructors play an important role in helping students overcome such barriers with academic and social support (Bers & Schuetz, 2014).

Overall, community college education research has relied on broad survey methods to study college instructors' practices without consideration of the subject being taught (Hardy & Katsinas, 2007; Eddy, 2007). Contextual factors such as the size of the school, location of the school and student demographics are often not considered in such large survey studies, even though those factors represent an important influence on instruction (Cornett, Yeotis & Twillinger, 1990). Although smaller studies examining a single instructor's practices have taken these contextual components into consideration (Sweeney, 2003; Ritchie, 1998), they are so narrow in scope that it is difficult to draw conclusions that will be applicable to a wider audience.

Therefore, I seek to fill this gap in the literature, which fails to consider the experiences, instructor beliefs and practices of those who teach approximately 30% of all college students in the U.S. at rural community colleges (Katsinas & Hardy, 2012). Specifically, I examine and describe the beliefs and practices of three experienced rural community college instructors in their biology classrooms through the theoretical lens of the curriculum development model (Cornett et al., 1990). Access to traditional four-year colleges is limited for many rural students, and the importance of reaching these rural students is often ignored in the science education research literature. My goal is to examine community college instructors' beliefs and practices specifically when teaching rural community college students.

LITERATURE REVIEW

In this brief review of the literature, I present an explicit definition of rural community colleges that distinguishes them from their urban and suburban counterparts. I also provide background information about previous research related to community college faculty beliefs and practices.

Defining Rural

There are various definitions used in education research to distinguish the rurality of schools. These include Carnegie classifications and student population size relative to town population size (Hardy & Katsinas, 2007). In this study, a rural community college is defined as being located in a town with less than 50,000 residents (USCensus.gov) and enrolling less than 2,500 students (Carnegie Classification, 2016). Community colleges with rural satellite campuses that enroll less than 2,500 students will also be considered rural in this study, provided data collection occurs at the rural satellite campus. A college must be located more than 30 minutes away from the nearest metropolitan city of more than 50,000 residents (USCensus.gov) to exclude smaller suburban schools.

Describing Rural Students

The rural descriptor often has a negative connotation in education research. It implies substandard education and a lack of financial and educational resources (Silverman, 2014). Equity researchers have noted that rural schools' small enrollment and minimal tax base have led to fewer resources available for students (Silverman, 2014). However, a new conceptualization of rural education advantages needs to be considered. For instance, rural students might have parental and extended family support to complete their education for improved economic opportunities (Hlinka et al., 2015). In a similar manner, rural community college students often have close relationships with their high school teachers, which leads to encouragement and support for future career plans, including the pursuit of a college degree (Byun, Meece & Agger, 2077). This support system is crucial for the 40% of all first-time college students who enroll at local community colleges (NCES, 2017).

This support system is strengthened by the fact that rural students tend to enroll at community colleges near their hometowns (Hillman, 2016; Hlinka et al., 2015; Korcich, 2014). Living at home and commuting to school removes the opportunity cost of leaving town to attend college. It also offers a stepping stone to transition to a 4-year college (Hlinka et al., 2015). However, these geographic limitations, described as education deserts by Hillman (2016), promote inherent inequities in college choice. Rural students have been known to travel, on average, 52 miles to a college campus, but that does not guarantee a quality education is available within that range of distance (Hillman, 2016).

Additionally, a local community college often has similar diversity to that of local rural schools (Avery, 2013). This lack of diversity can be an advantage and a disadvantage. It provides familiar surroundings for students who are used to the 74% white population found in community colleges, but it also leads to few chances for rural students to encounter viewpoints and stances that challenge their ideas about the world (Pini, Carrington, & Adie, 2015; Eddy, 2007; Hardy & Katsinas, 2007). Instructors can use this insular viewpoint, which primarily encompasses social issues within a single community, to promote science learning. But increasingly, education researchers are endorsing the use of global science issues to provide students with exposure to the greater world around them (Epply, 2017; Corbett, 2016).

Local community colleges are also much more affordable for students. Rural students receive more need-based Pell grants than their urban counterparts, indicating that rural students often face greater financial challenges to pay for school (Katsinai & Hardy, 2012). It makes sense, then, that community college students often are enrolled full-time in classes

while working full-time to pay their living expenses and tuition. In 2017, more than 60% of all full-time community college students were employed at least part-time (NCES, 2017).

Community college students face many conflicting strains on their limited time, including work responsibilities, school projects and family obligations. Family can act as a hindrance for community college students, as many are responsible for children or relatives (Hlinka et al., 2015). Family obligations have been shown to lead some community college students to stop their studies or fail to complete them (Hlinka et al., 2015). Bers and Scheutz (2014) coined the term “nearbie” for students who start their community college education but do not complete their degree. In their survey study, they found that students who did not finish college did not see the benefit of completing their degree and were pulled away by work and family commitments (Bers & Schuetz, 2014). The authors suggested faculty foster personal connections with students to combat these losses.

To encourage community college students to finish their degrees, Hardré, Sullivan and Crowson (2009) put forth that instructors should make the course content more relevant to students’ interests and career goals. Faculty use of cultural references related to students’ daily lives increases student motivation and understanding of the content (Zielinski, 2017). Although rural students are interested in the content their instructors share, they can still be dissuaded from completing their degrees because of a lack of necessary skills. Rural students often are underprepared for college-level courses and must then take remedial courses in writing and mathematics (Outcalt, 1999). This represents a direct challenge for community college faculty in rural locations, as science courses often require students to enter the course with adequate skills in writing and mathematics.

Overall, rural community college students represent a unique challenge and advantage for instructors. These students have strong family support. They benefit from staying within the comfort zone of their local, homogeneous atmosphere. Challenges to instruction include lack of student motivation to complete their degrees, under-preparation, and family and work commitments that pull them away from college studies.

Describing Rural Community College Instructors

The background characteristics of college instructors at these rural community colleges are also important to consider when addressing the problem of rural community college student success and achievement. Rural community college instructors are rarely well-versed in education studies compared to their urban or suburban counterparts despite the unique challenges that exist in teaching rural students (Howley, Howley & Yahn, 2014). In a national survey of faculty development, Eddy (2007) identified several challenges for community college faculty, 60% of whom worked at rural community colleges. These challenges include designing assessments for student learning and working with under-prepared students. Compared to urban schools, rural colleges have a smaller faculty base, and instructors must teach a wide range of subjects to provide a complete education for rural students (Eddy, 2007). For example, a single biology faculty member might teach general biology for majors and non-majors, upper-level biology courses, as well as nursing and health sciences courses. Although all of these subjects are broadly related to biological sciences, the likelihood that a single faculty member has completed graduate work to support his or her understanding of such a wide variety of content is unlikely (Katsinas and Hardy, 2012). Faculty also suffer from isolation because of the smaller size of their departments (Outcalt, 1999). It should also be noted that rural faculty not

only struggle with heavy teaching and service loads but also with technological limitations due to the lack of internet access in many rural areas (Salemink, Strijker & Bosworth, 2017; Townsend et al., 2013). This limits the amount of online resources available for use by the instructors despite the current push to include more technology in education (AAAS, 2011).

The typical community college faculty member has a master's degree in a related subject but not often a Ph.D. (Hardy, 2007). Rural colleges are at a distinct disadvantage to recruit such qualified candidates because of their rural location and lower pay (Eddy, 2007). Rural community college instructors usually live in the community and often become community college instructors after leaving a high school teaching position. One advantage, though, is that faculty at rural community colleges are more likely to be full-time instructors and to stay at the same college their entire teaching career (Katsinas & Hardy, 2012; Twombly & Townsend, 2008). This is advantageous, as these faculty have been shown to be more personally invested in the overall goals of the college, community and students through their advising, committee and community work (Zielinski, 2017).

Overall, while rural education research has increased in the past 20 years, this is often a result of a "rural by convenience" motive (Howley et al., 2014) rather than a focus on the unique rural context as an important factor contributing to a study's results. For example, some researchers find it easier to gain access to rural locations for education research due to less restrictions on research (Howley et al., 2014). Biddle and Azano (2016) assert that education programs need to critically consider rural-specific training for rural teachers rather than just promoting specialized training for urban teachers. The rest of this section will define the

concept of beliefs and describe what little is known about community college instructors' beliefs and practices.

Relating Beliefs and Practice

Previous studies have been conducted to further define the construct of beliefs and relate them to classroom practice. Pajaras (1992) warned researchers that they need to consider that beliefs are a “messy construct” to study, that they are complex and that they act as a filter for instructors to interpret their surroundings. Likewise, Jones and Carter (2007) defined beliefs as a complex system made up of teachers' beliefs about self-efficacy, epistemologies of belief and attitudes. They also described how beliefs are a perceptual filter of environmental influences on instructional practice (Jones & Carter, 2007). It is important to note that many of these models of belief were generated in K12 classrooms rather than in the context of colleges.

Because beliefs are inherently messy, Pajaras (2002) and Fives and Buehl (2012) have argued that researchers who study beliefs need to explicitly define them. For this study, I define beliefs as a lens that influences teacher practices and is used to interpret contextual factors surrounding teaching. Beliefs are categorized into personal practical theories, in alignment with the theoretical framework of the curriculum development model. This is discussed in more detail later in this paper. In short, personal practical theories are defined as a “systematic set of beliefs [theories] which guide the teacher and come from prior life experiences [personal] and classroom experiences [practical]” (Cornett et al., 1990, p150). These few varied definitions represent a small portion of beliefs research and show the importance of taking the contextual environment into consideration when studying beliefs and practices.

Community College Instructors' Beliefs and Practice

Although community college instructors are highly motivated to be better teachers and connect better with students through advising and smaller class sizes (Latz & Rediger, 2015), they struggle to implement reform-based instructional strategies such as student-centered teaching methods (Yarnall & Fusco, 2014; Brown et al., 2006). Student-centered instruction promotes less instructor focused lecturing while increasing use of activities and questioning which allows students to grapple with the content (AAAS, 2011). Drawing on the limited literature base of urban and suburban community college science instructional practices, I put forth that similar struggles with science instruction can be found at rural community colleges. In Table 2.1, I present an overview of different community college instructors' beliefs and practices, which have been shown in the research literature.

For instance, community college instructors face many conflicts between beliefs about using inclusive instructional strategies and their desire to maintain content and behavior standards in their courses (Gawronski, Kuk, & Lombardi, 2016). Instructors' decision-making, focused primarily on time availability and content coverage through simplifying their instructional modules, is in direct contrast to their stated beliefs about the importance of fostering inquiry skills (Yarnall & Fusco, 2014). Community college instructors have used various strategies to negotiate their beliefs about helping students and trying to include more reform-based practices, such as decreasing the complexity of student questions to encourage participation and reverting to lecturing (Mesa, Celis, & Lande, 2014; Ramnarian, 2014)

Table 2.1: Current research on community college instructor practices' and beliefs summarized

Community College Type	Instructor Beliefs	Instructor Practices	Reference
Urban/Suburban	--	Doctoral degree holders used less lecture and more discussion	Lei, 2007
Suburban	Instructors believed students "needed" assistance	Emphasis on teacher-centered instruction; Decreased complexity of discussion questions to encourage participant	Mesa, Celis & Lande, 2014
Suburban	Professed belief in inclusive instruction; Accommodating students lowers the course standards	Few implementations of inclusive instructional practices	Gawronski, Kuk & Lombardi, 2016
Suburban	Highly motivated to teach students in their classes due to smaller class sizes;	Give time to improve things they want to	Letz & Redinger, 2015
Suburban	--	Collaborative practices (i.e. group testing and student-driven topics); Classroom discussions linked to personal experiences	Zielinski, 2017
Rural	Didactic teaching is better for student learning than inquiry-based instruction	--	Ramnarain, 2014
Unknown	Teaching felt more genuine and stimulating	Implemented Vision and Change units – more student-centered instruction	Lynse & Miller, 2015
Unknown	Instructors need to make things easier on students	Only used inquiry-based modules which fit course content goals; Simplified inquiry-modules	Yarnall & Fusco, 2014

In contrast, other studies have found that reform-based practices, such as group testing and student-driven topic choice, are practiced in suburban community college science courses (Lei, 2006; Zielinski, 2017). Instructors link content to students' personal experiences and make the information more authentic (Zielinski, 2017). Faculty have benefited from using more reform-based practices because teaching feels more genuine and stimulating with increased student-teacher interaction (Lynse & Miller, 2015). These studies illustrate that observed practices associated with instructors' beliefs are complex. Therefore, this study broadens research about rural community college science instruction, not only by studying the beliefs of science instructors in this rural context but also by evaluating how those beliefs are manifested in their instructional practices.

THEORETICAL FRAMEWORK

As described above, the relationship between teacher beliefs and practice is complicated and often debated in the science education field. Context of instruction plays an important role in instructors' curriculum decisions (Birt et al., 2017; Box, Skoogs, & Dabbs, 2015). Thus, I adopted the curriculum development model used by Levin, He, and Allen (2013) to categorize personal practical theories based on Cornett et al.'s (1990) original model. This model takes contextual factors into consideration when discussing teacher beliefs. Next, I will explain the curriculum development model in more detail and describe previous research that has been conducted to examine instructors' personal practical theories and their relationship to practice and contextual constraints.

Curriculum Development Model

The curriculum development model is a cyclical model that includes instructors' personal practical theories (PPTs) at the center. PPTs, as defined previously, are a set of beliefs [theories] that are influenced by an instructor's life experiences [personal] and experiences in the classroom [practical] (Cornett et al., 1990). These PPTs influence all aspects of curriculum development and instruction in instructors' classrooms including the purpose, planning, practice and reflection on practice in a cyclical nature. More specifically, instructors' goals and purposes for their classrooms are influenced by their beliefs. These purposes, in turn, influence the planning done for instructional practices. For example, if instructors believe that a purpose of science instruction is to teach writing skills, they will plan and implement activities that include writing. Logically, instructors' planning directly relates to the actual practices they use and instructors' PPTs. In the final connection of the cycle, the results of the practices can inform how instructors reflect on the practices. But this reflection is also influenced by instructors' PPTs. In our theoretical example, instructors' reflections on student performance on the writing activity can affect those instructors' future writing goals or even their beliefs about writing instruction. Instructors might not complete the full cyclical model in practice because they might leave out the reflection portion or fail to use practices consistent with what they planned (Cornett, 1990; Box et al., 2015). This can result from several contextual factors that influence instructors' PPTs, limit the types of practices available to the instruction and curtail reflection on the results of previous practices (Birt et al., 2017).

In the original study to support the design of the curriculum development model, Cornett et al. (1990) categorized 7 PPTs for one middle school science teacher from three

perspectives. Although they showed that interviews and observation can help identify these beliefs when researchers are aligned with a teacher's professed beliefs, they failed to explain how the researchers separated themselves from the teacher's efforts to self-identify PPTs. The PPTs identified such topics as the teacher's influential beliefs about students and learning, which often overlapped and interacted (Cornett et al., 1990). Ritchie (1998) further studied PPTs, this time with an elementary school teacher. PPTs were described and categorized through stimulated recall. In effect, Ritchie (1998) asked the teacher to more carefully consider the reflection portion of the curriculum development model, completing the cycle and providing a clearer picture of the influence of PPTs on instructional practice. The researchers put forth that these types of exercises might help with professional development efforts. They can make teachers' thinking and beliefs explicit and allow them to reflect on their reasoning for including instructional activities (Ritchie, 1998).

New teachers have been shown to have different PPTs than beginning teachers (Sweeney, 2003; Levin & He, 2008, Levin et al., 2013). A new teacher's personal experiences are a powerful influence on his or her set of theories or beliefs (Sweeney, 2003). To make it more complex, more than one PPT can influence a teacher's practices (Sweeney, 2003). Levin and He (2008) instead examined pre-service science teachers' self-identified PPTs. Although they did not consider the fact that these PPT statements could have been influenced by the class assignment and students' beliefs about the instructor's expectations, they found that pre-service teachers rarely included beliefs about students but instead focused on instructional strategies and classroom environments (Levin & He, 2008). This indicates that the pre-service teachers were less concerned about student learning and more focused on classroom

management strategies. In a follow-up study, Levin et al. (2013) followed the pre-service teachers into the classroom two, four, and six years later to study their changing PPTs. Although the instructors' practices showed evidence of the original PPTs, the researchers also found instructors' PPTs became narrower and more student-centered over time (Levin et al., 2013). This study provides evidence that PPTs can change over time. This is logical: Instructors' practical experiences affect their theories (Birt et al., 2017). Thus, it is important to carefully consider instructors' years of teaching experience when selecting comparison participants for a research study.

With this broad theoretical framework, the purpose of this study is to investigate the types of overall practices included in rural community college science classrooms. Another purpose is to determine how or if the instructors consider the rural background of their students when planning, implementing or reflecting on these practices. As described by Kane, Sandretto and Heath (2002), it is important this study consider not only what the participant instructors say but also what they are actually doing in the classroom. Thus, the research questions are:

1. What PPTs do participating community college science instructors have about teaching rural students?
2. How do these PPTs manifest in the instructional and assessment practices planned and used by participant instructors?

METHODS

Research Design

To answer these research questions focused on rural community college instructors' practices and beliefs when working with rural students, a case study methodology was used (Yin, 1994). Three rural community college biology instructors were recruited for this study. Biology instructors were considered for this study if they had taught full-time for more than seven years, more than twice that of the typical tenure point, as a conservative number of years of teaching to be considered experienced in the research literature. The instructors needed to live in the rural community in which they were teaching as well as teach at a rural community college as defined in the literature review section. Due to the diverse physical contexts which can be classified as rural, Howley et al. (2014) and Coladarci (2007) have recommended that researchers explicitly describe the context of studies in rural education. Thus, detailed, contextual descriptions of the towns and colleges were included along with participant characteristics. To be considered for the study, the college needed to have less than 2,500 students enrolled, to be located in a town with less than 50,000 residents, and to be more than 30 minutes from the nearest metropolitan center with more than 50,000 residents.

Participants

Participants were recruited for this study using the snowball method, in which I contacted one instructor meeting the above-mentioned criteria and she connected me with the other two participants. The three participants—Meg, Richard, and Jane—were colleagues in that all were sponsors of their colleges' local Phi Theta Kappa Chapter, the international honors organization for two-year colleges. Instructors were recruited in the Spring and Summer 2018

semesters. Summaries of the participants and broad contextual information about their colleges are included in Table 2.2.

Table 2.2: College and participant instructors' characteristics summarized

	Meg	Jane	Richard
Years Teaching	15	12	26
School Name (Pseudonym)	Northbend	Southview	Eastside
Type of Campus	Satellite	Satellite	Main
Number of students	186	600	2300
Diversity	83% white	93% white	93% white
Town size (population)	12,000	19,000	11,000
Nearest Metropolitan area	1 hour	1 hour	30 minutes
Course Observed	Introductory Plant Biology	Microbiology for Allied Health	Microbiology for Allied Health
Number of Students	9	10	19
Semester Observed	Spring 2018	Summer 2018	Spring 2018
Hours of Observation	6	6	6

Meg is a full-time biology faculty member at Northbend Community College. (All instructor and college names are pseudonyms to protect the participants' privacy.) She has taught there for 15 years. Northbend is the satellite campus of a larger six-campus, 4,900-student area community college located in a town of approximately 12,000 residents. The nearest metropolitan area is one hour away. Northbend had an enrollment of 186 students with 83% identifying as white. Observations of Meg's Introductory Plant Biology course were conducted in Spring 2018.

Richard is a full-time biology instructor who has taught at Eastside Community College for 26 years. Eastside is the central campus of a rural community college with two campuses. The town in which Eastside is located has approximately 11,000 residents, and the nearest

metropolitan area is 40 minutes away. There are 2,600 students in the entire college, with 2,300 enrolled at Eastside's central campus. Ninety-three percent of Eastside students identify as white, and 53% are first-time, full-time students who have been awarded Pell grants. Sixty percent of the students are female. Observations of Richard's Microbiology for Allied Health class occurred in Spring 2018.

Jane is a full-time biology instructor at Southview Community College, which is the southern satellite campus of the same college where Richard teaches. She has taught biology at Southview for 12 years. The student population data are included in the overall data given about Eastside. Only 600 students are enrolled at Southview, which is located in a town of 19,000 residents. It is important to note that unlike the other two locations, Southview is located in a town that also includes a state university campus. The nearest metropolitan area is one hour away. Observations of Jane's Microbiology for Allied Health class occurred in Summer 2018.

Data Collection

Primary data sources included classroom observations and instructor interviews. Classroom observations (CO) were conducted for six hours of combined lab and lecture time for each of the participants over two days. During the audio-recorded observations, detailed fieldnotes were recorded, which included comments about instructional strategies and types of assessment used, instructor and student interactions, as well as student-to-student interactions. For instance, during a single lecture, instructional strategies such as an instructor's use of PowerPoint-supported lectures, videos, or extemporaneous speaking were noted. Any instances in which the instructor talked or communicated with the students, such as direct

questioning by the instructor or a student asking questions of the instructor, was considered an instructor-student interaction. The classroom observations served to inform the contextual factors affecting instructional practices and the practices portion of the curriculum development model.

Before the observations were conducted, a background pre-observation (PreObs) interview was performed. During this pre-observation interview, the instructor was asked to describe his or her teaching philosophies about instruction and assessment as well as the planning and reasoning he or she used for any instructional practices that might be applied during the unit of interest. Interview questions included: *How do you describe your instructional style?; Describe your instructional plans for this unit.; If you were unlimited by time, resources, etc., how would you modify your course?; In what ways does the presence of rural students in your class affect your instructional plans?; In your opinion, how might rural students differ from non-rural students you have previously instructed?* The pre-observation interview was used to gather data about instructors' plans for instruction and their views of the purpose and focus of instruction. The data also informed conclusions about instructors' PPTs.

Within one week following the observations, a post-observation interview (PostObs) was conducted with the instructor to allow for his or her explicit interpretation of how the course went during the observations. More specifically, Meg completed the post-observation interviews the day following each of the two observations, while Jane and Richard completed the post-observation interviews four and five days after the observations, respectively. For Meg and Richard, this post-observation data also included informal conversations noted in the fieldnotes immediately following observation. Notes of these informal discussions with the

researcher were included as an additional interview data source. Example formal questions include: *What did you feel went particularly well? Is there anything you would have done differently?; How well do you think the instructional strategies were effective for the rural students in your class? Why or why not?; Do you plan to alter your class based on your view of the effectiveness of your teaching?*

Artifact collection from the classroom served as a secondary data source in this study. The classroom syllabus informed conclusions of the instructors' course goals, planned instructional practices, and stated purposes of practices. Classroom assignments, quizzes, and exams were collected during the observation periods and used as concrete examples of implementation of practices of the instructor. Meg and Jane also submitted a copy of the most recent exam given as a secondary artifact. For validity concerns, an audit trail of data was included to ensure all data are collected as described and included in the data analysis (Yin, 1994).

Data Analysis

Data analysis drew on the curriculum development model and PPT components. Inductive coding occurred across all primary data sources including instructor interviews (PreObs and PostObs) and observations (Creswell, 2012). To answer the first research question about PPTs, instructors' theories were described in four draft theories derived from interview and observation data. Interview transcripts and observation fieldnotes were inductively coded to categorize instances related to instructor beliefs and instructional purposes, plans, practices and reflection. For example coding see Appendix A. During data analysis, memo writing

occurred after completion of coding each data source and included emerging themes, researcher reflections, and draft PPT statements to consider when analyzing later data.

Following the final inductive coding of all primary data sources, the draft PPT statements were revised, and condensed into two PPTs. Case narratives were outlined to include all data supporting the PPT statements as a whole across data sources. At this point, the secondary data along with observation were analyzed to answer the second research question related to manifestation of these PPTs in instructors' practice. Data were then used to create a case narrative to capture the interconnected nature of each of the portions of the curriculum development model.

To ensure internal validity of the conclusions of these PPTs, member checking occurred (Merriam, 2009). Instructors were asked to review the conclusions about their personal theories and case narratives to refine or confirm them (Merriam, 2009). In the instance of Jane and Meg, both approved and submitted no changes to their case narratives or PPTs. Richard approved of his case narrative but included minor edits to correct some inconsistencies, such as the number of dilutions included in a lab experiment and course information about pre-requisites. He did not change the overall structure of the narrative or the PPTs identified.

Analysis of all six components of the curriculum development model were used to construct rich, thick case descriptions for each individual case of the study. They explain how each instructor's PPTs and rural context affect their instructional practice. To ensure validity, a second researcher familiar with the curriculum development model reviewed all data, memos and case narratives to reach a consensus with the first author on the relationships between the PPTs and other components of the model (Merriam, 2009).

Following the single case description analysis, a cross-case analysis was conducted to determine if any insights could be found across and between the different instructors. Cross-case analysis compared and contrasted instructors' PPTs and beliefs about teaching and learning in a rural community college. The analysis also included comparisons of the instructional strategies planned and implemented by the instructors. Comparisons were made across the various levels of rurality in which the instructors taught to emphasize the rural context of the study (Katsinas & Hardy, 2012). The analysis identified Meg's Northbend as the most rural of the colleges followed by Jane's Southview. Richard's Eastside was the closest to a suburban school and the least rural.

RESULTS

Instructors' beliefs about rural students are presented in two condensed PPTs for each instructor in the form of a case narrative. Each instructor's case narrative begins with a description of the instructor's background, course of study and students in the course. This is followed by a detailed description of each of the six components of the curriculum development model that might be affected by the instructor's PPTs. Cases are presented in the order of increasing rurality beginning with Richard, the least rural, followed by Jane and then Meg as the most rural participant instructor.

Richard – “an anecdotal storyteller with high expectations”

Background and Course Description

Richard is an experienced biological science instructor who has been teaching for 26 years at the same Midwestern community college located in a town of about 11,000 residents.

At the time of study, Richard was teaching a 19.5-hour course load plus seven hours of office

time for the Spring 2018 semester. His Microbiology for Allied Health course was chosen for this study because of its importance in the biology curriculum for nursing majors. It represents important professional training for rural community college students.

Richard has taught this course nearly every semester since he was hired at the college, including the past 8 summers. He often teaches two sections. One is in the morning or afternoon, and another section is in the evening. Students in the section studied met on Tuesdays and Thursdays for several hours. For the first one and a half hours, the students met in a laboratory room for lab exercises. After a 15-minute break, the students moved down the hall to a classroom for the lecture portion of the course for at least an hour, depending on the day. There were 19 students enrolled in Richard's four-hour lab and lecture course. All of the students were female pre-nursing majors ranging in age from 18 to mid-30s.

The course covered the standard content of microbiology with an additional unit at the end of the course covering medically important microorganisms. The unit of observation included discussion of antimicrobials in the laboratory portion of the course and virology in the lecture portion. Richard maintains that he teaches complementary and supplementary information in the laboratory portion to support the content learned in the lecture portion of the course, but each part of the course remains separate in topic and assessment.

Richard's Personal Practical Theories

Two personal practical theories were identified related to science teaching and student learning. These guide and influence Richard's purpose, planning, practice and reflection on practice.

PPTr1: Science teaching should include real-life examples explained to keep students engaged and help them learn.

PPTr2: Rural students are capable of producing quality school work including knowing when to ask for help.

Next, I break down each of these theories individually into how they affect Richard's cyclical curriculum development model as evidenced in his instructional strategies. Finally, I note any instances in which these theories overlapped or came into conflict with each other.

PPT1 Richard: Science teaching should include real-life examples explained to keep students engaged and help them learn.

Richard provided students with examples of microbiology concepts with the goal of helping them remember and learn the concepts. In his background interview, he stated,

I try my best to make it relate to real life as much as possible... lots of anecdotal things, stories from past, stories or examples. I tell my medical microbiology students that I am a walking medical file so I can give them examples from me and my family and some of those things (PreObs p3).

Richard seemed to spontaneously think up these examples. But Richard explained in his post-observation interview that these examples are often, in his words, "recycled." They are the same ones he has been using successfully for years (PostObs2 p2). For example, during observation Richard included a reference to current events, describing a measles outbreak that had captured news headlines. Yet he interspersed this with other examples, such as the story of his family friend with lung cancer who was treated with antibodies; a description of Type 1 diabetes; an anecdote about the Hepatitis A vaccine he received before visiting Brazil; and

comments about home pregnancy tests. All of these references occurred within the first 20 minutes of one lecture observed. Upon reflection, Richard said of his practices of primarily lecturing using examples, “I’ve found for me it works well, and the feedback that I get from the students seems to be positive, so it’s been kind of ‘If it works for me, and the students seem to like it, then why change?’” (PreObs p9). These examples are included not only to help students remember but to keep the students engaged in the lecture.

Richard directly told his students, “‘If you can enjoy my class, then maybe you will take something home,’ so I hope they enjoy my class, but more importantly, I hope they take something home from it.” (PreObs p3). With regard to monitoring engagement during practice, Richard spontaneously asked questions of the students as a “pulse check to make sure they are still with me” (PostObs2 p1). Upon reflection, he explained that “I usually just try to gauge what is going on in class ... They just kind of, often they sit there and blink at me. I try to make sure there is a pulse behind the blink on occasion. That’s where when I ask a question once and a while, maybe they will respond to me” (PostObs2 p1). Richard noted that experience and practice led him to include pulse-check questions. It just occurred naturally during lectures.

Another way that Richard monitored engagement during practice was by noting if students were writing during the lecture. Richard described his PowerPoint-supported lectures as a signpost to keep him on track with the content that he wanted to present during that lecture (PreObs p2). Richard did not give the students access to the course PowerPoint slides because he believed that the students would use that as an excuse to not pay attention during lecture (PostObs1 p1). During observation, it was noted that students were quick to write when the PowerPoint slides were presented, but few students were actively writing when Richard

discussed examples or provided images for students to consider. Ideally, Richard said, he would add more small-group work to the lecture portion of the course. But he added, "... If you are going to do that, you are going to sacrifice lecture time. I just don't feel like we have enough time to be able to do that much" (PreObs p7). Richard justified the lack of change to his practice by noting that he promoted group work in the laboratory portion of the course (PreObs p7).

Richard's PPT as an explainer of real-life examples, was also prominent during the laboratory portion of the course. Richard described how he often drew on the experiences he had as a graduate student in a microbiology laboratory as well as the technical competencies listed by the American Society of Microbiology (PostObs2 p7). In practice, one of the labs observed consisted of serial dilution. Students took a bacterial sample of unknown concentration and then performed a series of nine dilutions by a factor of 10 to dilute down the sample. Then, they visualized the new amount on a new sample plate by counting colonies of bacteria. Richard told the students that such a procedure is used in the medical field to calculate the concentration of the number of microorganisms in a probiotic supplement. During the lab, Richard displayed his PPT as an explainer by walking students through a demonstration of the whole procedure before releasing students to complete the procedure on their own. Upon reflection about the use of this lab—which the lab manual company had deleted from its newer manual—Richard put forth that he planned to keep using it. This is because he thought serial dilution was an important skill for students to have upon entering the nursing program.

As evidenced above, Richard often considered his students' future nursing careers when planning instructional activities. He focused on making his class as true to professional life as possible. In the background interview, Richard stated,

I also tell them that they are going out there in the real world, and they are going to be working with organisms that could kill them, and they are going to be working with them on a daily basis, and my hope is that I have taught them some knowledge and respect of these organisms, and not to fear these organisms (PreObs p6)

In this microbiology course, Richard assigned a scientific research paper about a single organism of their choosing. For another assessment, students were asked to take a list of microorganisms and write out their characteristics within the strict format Richard provided. This goal of these assignment was to show students the variety of pathogens and give the students opportunities to practice finding more information about the organisms they might encounter in their careers (PostObs2 p3). Throughout his planning, practice and reflection, Richard's beliefs about the importance of using real-life examples for student learning are clearly evident, not only in the lecture but also the laboratory portion of the class.

PPT2 Richard: Rural students are capable of producing quality school work, including knowing when to ask for help.

Richard expressed a belief that rural students in community college do not need any special treatment, and he had high expectations of their quality of work. Richard credited his own past college experiences for this belief. He explained,

I started at a community college and it was 30 miles one way every day, five days a week for two years for me to get an associate's degree. So I understand that, I have empathy for the commuter community college student (PreObs p11).

He also noted that many of his students are parents and that he can empathize with them and the strains on their time. "And I'm a dad, it's not a big deal. I don't know, I can't speak for the

university, but I know when I was at the university, you didn't get any special dispensations for anything" (PreObs p11). Richard also discussed how he had to work and take classes simultaneously to afford to go to college (PreObs p2). Specific to microbiology, Richard explained that the microbiology course he took in college was much more difficult and included more content than the version he is teaching. Thus, Richard often expected students to keep to the quality of work that he put forth when he was a college student despite their many other commitments.

When directly asked about whether he gives special consideration to rural students in his courses, Richard responded, "Not really, I just treat them like college students" (PreObs p10). Richard had high expectations of students, both in terms of classroom attendance as well as the completion and quality of their work. With regard to returning adult students, Richard explained, "They are sometimes a little more challenged, and what I will try to do with them is offer them more help if they need it, but I'm going to expect that you are a college student, that you are going to put in the hours just like everybody else" (PreObs p10). Richard repeatedly expressed his belief that his student were adults capable to achieving a good grade with persistence and work.

Richard's high expectations are most clear in his planning for students coming to class and competing course assignments. As discussed previously, Richard did not provide copies of PowerPoint files to students with the express purpose of encouraging them to be present and to take notes to understand the content (PostObs1). Richard did provide some flexibility to students in that he was willing to help them if they requested it (PostObs1 p2). He provided bonus labs to allow for makeup of missed labs. Regarding lecture attendance and late

assignments, he stated, “And I tell my students my standing policy is, ‘If you work with me, I will work with you, and if you abuse me, I won’t work with you’” (PreObs p11). While Richard showed some flexibility with his expectations, he still maintained that students needed to be active participants in their education.

In practice, students were also held to a high standard in their course assessment outcomes. Several course assignments, such as the research paper and organism list, had strict formatting and content requirements. For example, Richard developed the organism list assignment to include an electronic format to ensure that all of the required information would be included. Yet over time, he has reduced the assignment from 20 microorganisms that must be researched and described to 10. In this instance, it appears that Richard has adjusted his expectations to accommodate students’ busy schedules by providing a shorter list with a template.

In his teaching, Richard planned instructional strategies that aligned with his belief that students learn from real-life examples and his high expectation of students’ actions. In practice, Richard’s lectures included many stories and examples from his life to make the content more applicable to students. He also held high standards for attendance and performance on assessments. While Richard rarely deviated from his storyteller role, Richard did show some deviation from his high expectations in that he was willing to work with students who actively sought his help with attendance or performance issues. It seemed that Richard saw a little of himself in his students’ challenges and struggles in completing a college course, even as he pushed students to personally engage with the course content in preparation for their careers.

Jane - “an adaptable, authentic science director”

Background and Course Description

Jane is an experienced biological science instructor who has been teaching for almost 12 years at a Midwestern community college located in a town with about 19,000 residents. At the time of study, Jane was teaching one course for the Summer 2018 semester. Her Microbiology for Allied Health Course was chosen for this study for several reasons. First, it is an important part of the biology curriculum for nursing majors, providing professional training to rural community college students. Second, it represents the course Jane teaches most often.

Jane has taught this course every semester, including all but one summer, since she was hired. She also teaches a few other general biological sciences courses. Over the summer, the course meets Monday through Thursday, starting with a lecture section in the morning for one and a half hours followed by the laboratory portion for two hours. To meet the course requirements, the lab is one hour shorter on Tuesdays and Thursdays. There were nine students enrolled in the four-hour course for the summer semester. All of the students were female and ranged in age from just out of high school to early 40s.

The course covered standard microbiology content with an additional unit at the end of the course covering medically important microorganisms. The unit of observation in the lecture portion of the course covered microbial growth and metabolism. The laboratories observed included experiments with serial dilutions, pour plate technique, secondary cell culture and practice gram staining. Jane integrated both the laboratory and lecture portions of the course by discussing laboratory concepts in lecture and connecting lecture content to the laboratory procedures and conclusions.

Jane's Personal Practical Theories

Two personal practical theories were identified related to science teaching and student learning, which guided and influenced Jane's purpose, planning, practice and reflection on practice.

PPTj1: Science teaching should use authentic practices to allow students to fail and ask questions.

PPTj2: Teachers should be adaptable and provide students a variety of opportunities influenced by student performance and feedback.

Next, I break down each of these theories individually into how they affect Jane's curriculum development model components as evidenced in her instructional strategies. Finally, I note any instances in which these theories seemed to overlap or be in conflict with each other.

PPT1 Jane: Science teaching should use authentic practices to allow students to fail and ask questions.

Jane found that it is important for students to learn through authentic science practices such as problem-solving around failure, scientific writing and working in groups. First, Jane believes in the importance of allowing students to experience some failure leading to learning. She described her reasoning about the laboratory portion of the course,

A lot of students learn better if they've stepped wrong. Sometimes they will actually remember to do it right next time if they have said, 'Oh wait, don't do that, do this instead.' And it is more like real research, which some of them get a benefit of experiencing real research. And I don't have a lot of students that are going to go into

research as careers, but it's still a good thing to see how scientists actually work (PreObs pg2).

Jane described her labs as "chaotic" (PreObs p2) in that there was minimal consistent structure. She did not lecture about lab techniques or include a long lecture before lab to explain the concepts related to the lab exercise. She described the source of this chaos as follows,

The chaotic thing just kind of happened, too, but that's older, back even when I was a TA and they said, 'OK, you will start the lab with this half-hour lecture on photosynthesis.' My lab was still, 'OK, give it a try and we will see what happens' (PreObs p2).

She promoted student curiosity and failure. When one student wanted to see what would happen to her cultured neon bacteria over time, Jane encouraged her to leave the plate in the incubator and check and see in a future lab session.

Other instances for learning through failure were also seen in Jane's assessment practices. Ungraded in-class assessments were used to expose students to possible failure. Students held up a paper response card with their answer to the question, which Jane called a clicker question. In one of the clicker questions observed, she asked students to do a bacterial generation time calculation. Upon reflection about this practice, Jane noted,

I am trying to add more of the clicker questions because I think they work, and then one thing I did today, literally, I had two questions in a row, they were kind of the same questions, just with different math. And I have had good success because the first one they don't get, and we have to talk through the whole thing, and then the second one most of them get, and then the third one they all get (PostObs p5).

Jane also said that these clicker questions helped students realize what they do not know. But she emphasized that their strength is in helping students be confident about what they do understand (PostObs). Thus, to Jane, the use of these types of assessments helped students to gain some confidence in their knowledge following previous failures.

Another scientific practice that Jane purposefully planned into her course is the use of scientific writing for learning. When planning her course, Jane included instances of scientific writing such as a research paper to allow students to practice paraphrasing, a skill she had found lacking in students (PreObs p5). When prompted for more information, Jane explained, “Part of it is that they don’t know enough about the thing to paraphrase it. It is hard to paraphrase something that you don’t understand.” (PreObs p5). Jane equated this skill with using critical thinking because students are required to put several pieces of information together to make a conclusion (PreObs p8). Although Jane did not explicitly list critical thinking and writing skills in the formal learning objectives for her course, she still included them in her own personal goals for the course.

The final scientific practice that Jane believed promoted learning was the use of group work. While group work was most common in the laboratory, Jane also used group work in the lecture portion of her course. Through group assignments and activities, she explained, students with different learning styles help one another complete activities. As Jane reflected on the requirements for a metabolism list that the students compiled together in class, she noted that while individual students’ lists had weaknesses, working together enabled them to combine different perspectives to compose a full list. Thus, she planned to continue to use this activity to promote students working together to review cell metabolism needs (PostObs p5). In

another observed activity, students worked in groups of two to complete a concept map of gram staining. Sometimes, students are uncomfortable with the concept map format, Jane said, but when she put them into groups, they are able to complete the assignment. She explained,

I don't think I do concept maps as individual activities ever because some people just don't get concept maps and so it wouldn't be. It would be so frustrating for them, so those people can just answer questions from their classmates instead of trying to figure out what goes in what box (PostObs p2).

In summary, Jane strategically planned and incorporated the scientific practices of problem solving through failure, scientific writing and group work because she saw that these practices had value in promoting student learning.

PPT2 Jane: Teachers should be adaptable and provide students a variety of opportunities influenced by student performance and feedback.

Jane described her role in the course as a Socratic lecturer whose job it was to present some information and then ask questions (PreObs p2). She also defined her roles as "to encourage [students] to care about the information and point out what is important." (PreObs p6). The use of many questions in her lectures allowed Jane to be very adaptable in her instruction.

Jane also encouraged students to not only answer the questions but ask questions. She explained that,

I think students learn best when they want the information. And so I like to let them ask the question instead of trying to anticipate the question. And they are not all coming

from the same place, so I try to keep in mind where they are starting from when I start (PreObs p3).

When Jane asked questions of the students, she did so with the purpose of finding out how well the students could apply the information covered (PreObs p2). In a similar manner, Jane's varied instructional strategies were designed to encourage the students as well as to provide some insight for Jane about student understanding.

Rather than just use formal tests to assess student performance, Jane had a wide variety of assessments included in her course. She stated that she did this so that, "They have different ways to show me that they know the stuff or that they don't" (PreObs p5). The course included over 1,300 total points, with the lab accounting for only 400 of those points and the remaining points coming from other activities. Assessments included homework, online quizzes, in-class individual and group quizzes, worksheets, definitions, a research paper, laboratory reports, and practical and written exams. When asked why she used so many different activities, Jane explained,

I have a variety of stuff because different people like different things. And probably different people will remember whatever from different ways of doing it. And I don't feel like I should add more, I try to take something out if I am going to add something new, otherwise it would take like four semesters to get through all the stuff I've ever done. That I think worked, but you can't do it all every time (PostObs p6).

Jane made course-planning decisions quite spontaneously, sometimes within a lecture, based on feedback from students. She described her spontaneity as, "Oh no, I never know until I am standing there and words are leaving my mouth. And it all works out every time. So it's not the

same, but I don't feel like I am short-changing classes" (PreObs p11). While Jane admitted that she often has to do enough planning to be sure to bring paper copies of an activity to class, she did not usually make the final decision about which activities to use until she was in the classroom. When asked how she makes her instructional decisions, Jane explained,

I adapt assignments all the time and what kinds of activities they do in class based on what they are getting out of it. So if I do a certain kind of activity, and then I give a quiz, and they all do really well on the quiz, then I will do more of that activity. If they all do tragically poorly on the quiz, I will not do that activity again (PreObs p6).

Therefore, one type of feedback Jane used in her decision-making was student performance on content-based quizzes.

Another factor that Jane considered was student enjoyment of the activity. When describing the concept maps, Jane explained,

If the first time I do one, and the students clearly all hate concept maps, and it skews towards the "I hate this thing," then I will do like one more of them, but the gram stain one is the only one I always do (Post Obs p2).

Additionally, Jane considered students' personalities when assigning activities such as one that asked students to fill in the enzymes in a metabolism pathway (CO1). She sought to understand her students' abilities to cope with new types of assessments.

Finally, Jane used students' facial expressions as feedback on her instruction. When directly asked how she judged student understanding in her lecture, Jane stated, "Usually just, sometimes I look at their faces, and if they look completely confused, I will back up." (PreObs p3). Jane described another case in which a student made a face at her. In that situation, she

“explained it again, and [the student] said to me, ‘I understood that, I was making a face about something else,’ and the girl behind her was like, “Thank you, I didn’t understand it the first time” (PostObs p6). It was clear that while lecturing, Jane was aware of student reactions and engagement: She described how she once stopped lecturing during the middle of class to introduce a new assignment because a student was falling asleep (PreObs p7).

Interestingly, despite her varied activities and assessments, Jane strongly professed that technology should only be used for instruction when it has been proven to work consistently and to be accessible to all students. Jane rarely used the online resources available to her for her course. She explained this is because not all students have high-speed internet in their houses or on their phones. She said,

I hear all the time, “Well, everybody has a smartphone,’ and that is just not the case and I am not going to do a whatever that excludes one student because that is really not fair. And a lot of them, and especially the one that doesn’t have a smartphone, they are here because they’ve been excluded from everything forever, I’m not going to be part of the problem (PreObs p10)

Instead, Jane found other ways to adapt to meet a similar goal of gauging student understanding without putting any students at a disadvantage: paper response cards. She explained the response cards cost very little and “they are less prone to error... It is a little less anonymous than the electronic ones, but it works every time. They don’t blip out, the software doesn’t crash” (Post Obs3). Jane was adamant that she will add more technology to her class when the technology she has works well. Her ability to adapt in the absence of functional technology was true in both lab and lecture. Jane always came to class with backup printouts of

anything that she planned to display on the projector screen so her course could continue even if the computers in the room were not working.

Overall, Jane's beliefs about instructors being adaptable and varied were clearly evidenced in her planning, practice and reflection of her instructional strategies and assessments in the microbiology class observed. Although she rejected some newer technologies because of lack of student access and reliability issues, Jane used a wide variety of instructional strategies in her observations. In a similar manner, evidence was found to support Jane's belief that instruction should use authentic science practices to provide learning opportunities for students. Jane clearly believed that each student group was unique, provided unique challenges to instruction and was readily adaptable to take on the unique context of teaching rural community college students.

Meg – "An engaging and motivating skill builder"

Background and Course

Meg is a full-time instructor with more than 15 years of teaching experience at Northbend Community College. Northbend had 186 students enrolled in Spring 2018. The class observed and studied was the introductory plant biology course that had nine students enrolled at the time of study. This college was located in a Midwestern town with 12,000 residents. Meg was the only full-time biology faculty at this satellite location of the community college and taught 30 hours of courses during the semester of study. The course met only on Tuesdays for three hours, which was split between laboratory and lecture. The split changed each week depending on laboratory activities. It is important to note that this course was considered a hybrid course in which students only meet once per week with additional work in the online

classroom. This was the first time Meg had taught the plant biology course in more than five years and the first time she had taught it in the hybrid format. This course was specifically chosen because it was a new implementation rather than a regularly taught course for Meg.

Meg's Personal Practical Theories

Meg's PPTs were best characterized by two statements. She based her instructional decisions upon beliefs that

PPTm1: Science teaching and learning should be engaging and include incentives to keep students interested in the content.

PPTm2: Teaching science is about teaching skills supported by broad content knowledge.

The rest of the results were broken down based on these two PPTs and their manifestation in the instructor's purpose, planning, practices and reflection on her instructional strategies.

PPT1 Meg: Science teaching and learning should be engaging and include incentives to keep students interested.

Meg strongly believed that part of her role as the instructor was to make sure that students stayed motivated and engaged in the course. She described her instructional style this way,

I do have moments where it is kind of me telling and lecturing. I still do more traditional lecture format ... but I think there is also when you are doing that, you have to kind of read your audience really well and make sure that you are not losing them (PreObs p1).

Her goal was to present engaging lectures so that students' interest was tapped to lead to learning. For instance, her instructional plan was to use PowerPoint slides to explain the

information to students, but she inserted break-up activities to get students to “stop and think about what they were talking about so that the [subjects] are not just a big blur” (PostObs1) In one observed session, she paused her lecture to have students review and categorize the plant hormones just discussed while she kept a record of the discussion on the whiteboard (CO1). She had planned this, but upon reflection she described how she expanded it longer than originally intended because she noticed the students were not actively writing or paying attention to the lecture.

In addition, Meg often included real-life examples that were relevant to students’ everyday lives to help increase their interest in the content. During a single lecture period observed, real-life examples included the skin color of bananas; sunflowers; corn; the ripening of apples; human development; marigolds; and balloons, to name a few (CO1). Often, these examples were related to agriculture. Meg explained, “Using real-life examples, trying to connect to stuff they would understand. Especially with science with the non-majors courses can get very techy, especially with terms, so you can lose students very easily” (PostObs). Meg tried to use these real-life examples to make the science more tangible to her students.

Upon reflection, Meg concluded that the students were still not actively engaging in the course lectures. She noted, “They just don’t pay any attention during lecture, so I have just kind of forgone that” (PreObs2). Instead, by the final observation, Meg started to implement new in-class activities to help increase student engagement. Rather than lecture, Meg required students to print off the usual PowerPoint notes. Then, they worked in their laboratory groups answering questions and considering scenarios about the content (CO2). She described her reasoning behind these changes to be that her students were very hands-on, “so I think that

sometimes, when you have the more mechanical students, if you give them something to do, they are more engaged with it”(PostObs2). Therefore, keeping students engaged represented an integral part of Meg’s instructional practices.

When describing her course, Meg noted that students not only needed to be interested and engaged in the material but also needed other motivation to take advantage of all of the learning opportunities in the course. For example, Meg planned to include 1,300 points of assessments, which included points for lab reports, online discussion, online quizzes, take-home exams, a research paper, a semester-long experiment, a presentation and attendance. Her purpose in revising the course to include less lecturing was that “they get a lot more out of being forced to go through the lecture notes and write stuff down. So it’s kind of a forced study guide”(PostObs2). For more motivation, Meg took class time to explain to students why they were being asked to complete a certain assignment, rather than assuming student buy-in.

In the online portion of the hybrid course, Meg found that she needed to carefully plan the learning activities to encourage students to participate in a timely manner. For example, every other week, students were supposed to post and respond to an open-ended discussion thread online. During the semester, Meg found that students were waiting until the last minute to post their original response, which did not allow time for productive discussion to occur. Upon reflection, she said, “I did change it so they have their original post done by the first week and then their responses can then be the second week ... I wanted to try and force them a little bit” (PostObs1). With reference to the online quizzes, Meg described their purpose this way:

The quizzes they do well on, as I've set them up more like a homework format, so they get two tries at them, just trying to get them to really get in there and look at the material, not necessarily penalize them on whether they know things or not (PostObs1). Meg's practices firmly showed how she used online and in-class assignments worth class points to help motivate and, in some ways, force students to complete the assignments—which she viewed as an important part of their learning—without penalizing them for practicing with the concepts.

PPT2 Meg: Teaching science is about teaching skills supported by broad content knowledge

Meg described how her goal was to help improve students writing, speaking and thinking skills because those abilities are vital to being an informed citizen. First, Meg wanted to help students think critically and globally. Meg reflected,

In many ways, what you see in our students is that oftentimes they are very insular.

What I mean about that is that they do not have a very good perspective about what the rest of the world is like. I mean, outside of this small little town they live in, so thinking globally is very challenging for them (PreObs1).

To alter this insular mindset, Meg planned and practiced online and in-class discussions that asked students to consider how plants were used in other countries as well as content that might be uncomfortable for them, such as evolution. While Meg was warned when she took the teaching position in the rural town that she would receive pushback about teaching more controversial content, she has found students to be much more willing to learn more.

She also planned laboratory assessments to include critical thinking components, such as asking students to apply the laboratory concepts to a new situation. She connected the critical thinking to the other skills of writing and speaking. Meg explained, “And then you know kind of along with more knowledge-based critical thinking, helping them to become better writers and speakers so doing assessment where they are forced to do those sorts of activities and get feedback” (PostObs2 p2). Thus, Meg recognized the importance of that feedback to students when promoting skill growth.

Next, Meg wanted to foster students’ writing and speaking skills. She described her students as adverse to speaking publicly: “A lot of my students are really shy. So if you ask them to ask a question during class, they will avoid it like the plague.” To help alleviate this fear, she scheduled the speaking assessments for later in the semester so that the students were more comfortable with one another. She also assigned a research paper in which students were asked to find and explain information about a plant of their choice. The research paper assignment included several opportunities for instructor feedback and revisions with the goal of improving students’ writing. Meg encouraged several students to pick more interesting plants for the paper (PreObs1). This represented an intersection between PPTm1 and PPTm2 in that she did not want the students to get too bored with the assignment and therefore become unmotivated to complete it.

It was evident that Meg cared about her students and wanted to improve more than just their content knowledge but also their skillset. Meg’s course was directed toward non-science majors who needed a science course to finish their general education requirements, but she put forth that she still focused on skill-building in the major’s courses that she teaches.

Besides fostering skills, Meg actively showed that she also was concerned with students' engagement and motivation in the science course. Overall, Meg acted as an engaging and motivating skill builder.

CROSS-CASE ANALYSIS

Three themes emerged in the data when the three cases were compared and contrasted across the various levels of rurality: 1) The rural instructors used instructional strategies and assessments they thought would be best to help students succeed in their future careers; 2) The rural instructors all believed strongly in their role as an explainer and in the use of real-life examples; 3) Group work was important in rural science courses. The following section will present direct comparisons across all participants (Table 2.3) into these three themes.

Table 2.3: Summary of cross case comparison of participant instructors' beliefs and practices.

Characteristic	Meg	Jane	Richard
School context	Most rural	Rural	Most suburban
Beliefs about student learning	Students needed to learn skills through practice – writing, speaking and thinking supported by content knowledge	Learning happens when students fail – promoted authentic science practices through writing and group work	Students needed to learn the content knowledge needed to be good nurses
Beliefs about teacher's role	Engaging explainer – used real life examples to keep students interested and engaged in the material	Socratic Lecturer – presented information and asked questions	Anecdotal storyteller - explain and engage students through real life examples
Beliefs about group work	Group work is important in both laboratory and lecture	Group work is important in both laboratory and lecture	Group work is best in just the laboratory
Accommodating rural students	Motivating and Hands on – adapted course to include more activities and less lecture to force students to engage with the material	Adaptable – included many different course activities and made decisions based on student enjoyment and performance	No accommodations – rural students are capable of quality work and knowing when to ask for help
Instructional Strategies	Powerpoint assisted lecture	Powerpoint assisted lecture	Powerpoint assisted lecture
	Laboratory Experiments	Laboratory Experiments	Laboratory Experiments
Assessments	In class activities	In class activities	
	Research Paper	Research Paper	Research Paper
	In class student presentations		
	Online Quizzes	Online Quizzes	
	Quizzes – Individual	Quizzes – Group and individual	Quizzes - Individual
	Take home Exams	Traditional Exams	Traditional Exams
Other	Real life examples – agricultural, daily life, and history	Real life examples – related to medical or laboratory settings	Real life examples – related to health and medicine
	Students encouraged to print powerpoint slides	Students encouraged to print powerpoint slides	Students were not given access to powerpoint slides
	Strong online component	Some online quizzes and activities	Few uses of online course structure

Theme 1: Rural instructors used strategies to best help students succeed in their future careers

First, when discussing rural students, both Jane and Meg thought that it was important to teach skills to students rather than just content knowledge. Meg, the most rural instructor, planned assessments that promoted students' growth in their speaking, writing and thinking skills. She believed these skills were important for them and needed cultivating because of their shyness and rural background, regardless of the career they might choose in the future. In a similar manner, while it was not an explicit course objective, Jane included writing and critical thinking as an important part of her science instruction. On the other hand, Richard, the most suburban instructor, did not design his course in such a way as to teach these skills. He focused on teaching students the content he thought they needed to be good, knowledgeable future nurses. Richard did not plan activities to teach these skills. Instead, he noted, students would learn those skills in other courses as part of the college's overall objectives.

Richard's practices were rigid in that he did not incorporate any changes in his instruction directly aimed at helping rural students specifically. Richard had high expectations of students stemming from his experiences and the effort he put into his college years. Despite this viewpoint, he made it clear to students that he would work with them to find the best solution for them, even if it meant they needed to drop his course for the semester and take it again another time (PostObs2). In contrast, Meg purposefully included many points in her class to allow students ample opportunities to keep up with the work despite their busy schedules. In a similar manner, Jane added many smaller quizzes and assignments in her course to allow students different ways to show her what they had learned and to ensure one bad exam would not affect their grades too much. Jane and Meg both allowed for some excused assignments in

cases where students were unable to complete the assignment. This limited drops in students' grades because of incomplete assignments. Thus, all three instructors regardless of rurality had a goal of helping all their students succeed. The data did indicate that as the level of rurality increased, instructors increasingly emphasized the importance of supporting students' growth in skills rather than content knowledge. They also emphasized the value of including many opportunities for students to earn enough points to pass the class.

Theme 2: Each rural instructor's role was as an explainer who included real-life examples

When comparing the instructional strategies of the instructors, I found that all three relied heavily on PowerPoint-supported lectures. They felt it was important that they explain the content to the students directly. While Meg adapted her course in the end to include less lecture, she still felt it was necessary to provide the students with a copy of her PowerPoint slides so that the students could use the information contained on them to complete the assignments. This acted as another way for her to explain what she thought was important content to the students. Jane also encouraged students to print out the PowerPoint slides and provided all of the slides at the beginning of the semester to students. By contrast, Richard did not post his PowerPoint slides for students and instead expected them to write notes about the information given on the slides.

All three also used real-life examples in their lectures to add to this explanation portion. Richard drew heavily on his own personal health experiences to pique students' interest. Alternately, Meg often connected the material to students' daily lives through examples such as bananas ripening and balloons inflating, along with agricultural examples. Jane's examples fell into both of those categories because she included some health examples but also some

examples directly related to the lab the students were doing or related to their everyday lives, such as the use of honey as an antimicrobial.

Theme 3: Group work was important in rural science courses.

The three instructors used group work in their science courses in different ways. Richard, the most suburban instructor, used laboratory time as a chance for students to benefit from working in groups. He did not sacrifice lecture time for group work. Both Meg and Jane used group work in the lab, though Jane's lab procedures included each student doing some independent work, such as making their own plates and their own dilutions. In contrast, students in Richard's and Meg's labs worked together to complete a single experiment shared by the group. Jane and Meg, the more rural instructors, both connected the lab activities to the lecture content, while Richard kept the two parts of the course separate in assessment and instruction. This is noteworthy because while Richard and Jane both teach the same lab exercises, they do so in distinctly different ways. Richard strongly agreed that the lab was supplementary to the lecture portion of the course. He felt no need to connect the two. Jane believed that through the lab, students could apply the lecture concepts by working together.

Group work in the lecture also varied from one instructor to another, but there were commonalities in Meg and Jane's classes. Both planned and included group assessments in which students worked together to complete more challenging assignments. Meg and Jane used whole-class response activities in which they actively used a whiteboard to record student answers to multi-part questions. In contrast, Richard, the most suburban instructor, rarely engaged the students directly during the lecture portion of the course except to ask for an answer to a specific question about content or life experience.

Intriguingly, the instructors' practices and beliefs appeared to manifest in a more student-centered manner as the instructors' context became more rural, although I cannot draw causal conclusions based on case-study data due to many other possible explanations for the trends in practices and beliefs. Regardless, it was interesting to note that Richard, the least rural instructor, represented the most teacher-centered instructor with didactic lecturing and laboratories that were closed-ended with a single expected outcome. While this did not represent a negative mark on his ability to teach the students well, it is a thought-provoking distinction. Jane represented the middle ground in both rurality and practice. She often cited her role as the explainer but still included many student-centered activities and allowed for student-driven experiments in the laboratory. Finally, Meg represented the most rural and most student-centered instructor. By the end of the semester, she had adapted her class to include almost no instructor-led lecturing but rather had students working through activities designed to expose them to the material and challenge their understanding.

DISCUSSION

This study adds to the literature about rural community college instructors' beliefs and practices. I provided a detailed glimpse into community college biology classrooms and further described the connection of beliefs within the rural context in which they were teaching. Next, I discuss the theoretical outcomes of these case studies for further research into instructor beliefs and practices.

Research into instructors' beliefs is an active field of study, and many researchers use the construct of personal practical theories for categorizing beliefs (Levin and He, 2008; Levin et al., 2013; Maanaran et al., 2016). As noted before, often these beliefs are not situated in a

specific context of instruction but rather collected via survey methods across a wide range of participants. My studies' results support the theory that the context of instruction is an important and necessary consideration when evaluating and categorizing instructors' personal practical theories. The descriptive nature of the multiple case studies revealed that each instructor navigated their rural context differently. Meg considered students' insularity when designing and using assessments related to global issues. Jane adapted her instructional strategies to reduce the negative consequences of missed work for her students and used minimal technological teaching tools. Richard designed his courses while considering the students' future careers in nursing.

In contrast, numerous studies of instructors' personal practical theories fail to consider the teaching context (Maaranen et al., 2016; Sweeney, 2003; Levin & He, 2008). When instructor beliefs are taken out of context, then their connection to practices is unclear and useless for those working to reform instructional practices. For instance, Maaranen et al. (2016) found that pre-service teachers wrote PPT statements that reflected their idealistic view of the nature of teaching and less emphasis on practical considerations. This contrasted with the findings of Levin and He (2008), who relayed that their pre-service teachers were more focused on classroom management strategies. Both of these studies failed to contextualize where these beliefs would be applied.

In my study, the instructors considered the rural context of their teaching as well as the course content when discussing their instructional strategies. Thus, I note that when PPTs or teacher beliefs are studied, without using the complete curriculum development model to take the teaching context into consideration, then important facets of the PPTs are missed or

overlooked. This idea is consistent with other studies of instructors' beliefs outside of PPTs. Jones and Leagon (2014) postulated a model of teacher beliefs, which was placed within the context of instruction. They also noted that metacognition, or reflection on practice, was an important tool. It stands to reason that this reflection would not be possible if the practices and beliefs are not tried in the context of instruction. Therefore, I put forward that studies of instructors' beliefs must include the context of instruction along with instructor's' practices to fully examine teacher thinking.

CONCLUSION

This study broadens the field's understanding of rural community college science instructors' beliefs and practices. More than adding to the literature base, this study has practical implications to help other instructors who might have an influence on the science instruction of students with a rural background. Therefore, I finish this paper with two implications for instructors and professional developers, one remaining question, a discussion of the limitations of this study and a final encouraging note.

First, college instructors at both two- and four-year institutions need to be aware of their students' backgrounds. One-fourth of rural college students attend a community college before transferring to a four-year institution (Byun et al., 2017). This study found that experienced instructors in a more rural location often carefully considered students' motivation when designing their courses. This manifested in the sheer number of points available for the many assignments as well as in the types of activities chosen by Jane. She admitted that no two semesters were exactly alike in practice, but all students learned the same content. The only difference was the method that got them there based on each semester's unique student

interests and strengths. Another factor related to motivation is that rural instructors included examples that were relevant to rural students, such as agricultural examples or human health examples. If instructors use broadly relevant examples that appeal to all students regardless of the size of their hometown, they can help students understand content better (Avery, 2013).

Second, professional developers, who work with instructors who might teach rural students, can use the curriculum development model and the above results to inform their development strategies. Requiring instructors to explicitly express their current beliefs and understanding about rural students would help them make clearer connections between their planning and practices as it relates to these students (Levin & He, 2008). Also, helping instructors better understand the struggles rural students face will help them look past the seemingly underprepared and unmotivated student to see the student underneath who is instead struggling with changes in culture as well as family demands (Hlinka et al., 2015).

Future studies are warranted to dive into the differences in instructors' beliefs and practices in various rural contexts. A direct comparison study that looks at instructors' beliefs in rural and urban schools would lead to clearer contrasts and conclusions about the effects of rurality. But this would also be muddied by the myriad differences in context related to the diversity of student populations. Another realm of future study would be to examine student learning and transfer outcomes connected to instructor practices. Any study that leads to further information about how to improve the success of rural students is an important study to pursue.

Finally, this qualitative study had some limitations in drawing connections between the rural context studied and instructors' beliefs and practices. The clearest limitation is the

number of instructors studied was limited to three. But I put forth that if more instructors had been included, the depth of analysis would have suffered and would have resulted in a more survey-like study of practices. Also, this study is limited in its generalizability to other rural contexts. Although this remains true for the specific examples of instructional strategies, many of the practices and beliefs presented above are common across other community college instructors published in the literature base.

It is unique that the experienced instructors in this study actively used more student-centered strategies and openly expressed their desire to carefully motivate and expect their students to succeed. This directly contrasted with previous findings that instructors hold negative views, such as that these contexts foster disadvantaged students, and that most community college instructors rely on didactic practices (Hillman, 2016; Hlinka et al., 2017; Mesa et al., 2014). If we can pivot and begin placing a value on training instructors to teach rural students—rather than ignoring the context in which almost one-third of U.S. students begin their educational journey—then perhaps we will begin to fully appreciate the social, political and economic diversity that rural students bring to our college campuses (Epply, 2017; Biddle & Azano, 2016).

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APPENDIX A

Excerpt from Meg Pre-Observation 1 Interview

Data Analysis Below for Manuscript #1 RQ#1 What PPTs do CC instructors have about teaching science to rural students?

PPT/Beliefs Characterizing Rural Students Practices Affordances Hindrances

<p>JB - How would you describe your teaching philosophy for how you think learning occurs?</p> <p>Meg – So, my big things is presenting things in as many ways as possible, so that students who learn in different ways have different options. I think that science plays into that particularly well because you can talk about something and then you can show it, you can do some visuals and then you can do some hands on stuff, so I try, that's the nice things about having such long class periods. We kinda get to do all of those things all in one day. So tomorrow we'll talk about it, we'll do some short video clips, that they can take with them, and then we will do lab. So that's one of the big things. The second thing is just making students feel engaged. I think that is really, really important. Using real life examples, trying to connect to stuff they would understand. Especially with science the non-majors courses can get very techy especially with terms and so you can loose students very easily. So I think the more you can really use real life examples the better. You know group work, we do lots of group work in labs, this group particularly they have lab groups which are doing a semester long project as well. So that they've, hoping they can learn a little about the scientific process and how science occurs. So they've each designed their own experiment and come up with their own hypothesis and they are actually carrying it out. Now they are really rudimentary experiments, of course, but it at least gives them a sense. I really like that they will probably fail a few times and I think that is really important. Well because I think they often come in with the opinion that science is a certain way and that it always works out the way they think it's going to (JB it does in high school, come on) it gives them a chance to play with that. We do that. Let's see. And then my over-arching philosophy in all my classes is that you need to have three skills when you leave college. You need to be able to write well, you need to be able to speak well and you need to be able to critically think. So the critically thinking component comes in with labs and things like that but I do have them do a semester paper and they do it in steps so that they get feedback on it. So they do a first draft, outline and rough draft and they have the opportunity to submit additional drafts and they can choose to, they don't have to</p>	<p>Different ways</p> <p>Long class periods -> pro</p> <p>Engaged Practice – RLE</p> <p>Students – “would understand”</p> <p>Practice – group work</p> <p>Students – “rudimentary” changing views of science</p> <p>PPT – three important skills</p> <p>Practice – paper writing</p>
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<p>submit, but they have to submit that first draft to get at least one set of feedback from me and then they have the final draft on whatever that topic is they are writing about they get the chance to present about it to the class later in the semester. That is one of the last things that we do.</p> <p>JB- Yes, I noticed there was a presentation day.</p> <p>Meg – Yeah, so we'll spend that day and they will get to do. They're 15 minutes so they are not super super long but get some practice. I do it late in the semester because I figure at that point, this group is actually a pretty close knit group already, but sometimes it takes the students a little while to know each other. That way by the time they are presenting it is not such a huge task. Because public speaking is really hard for some of them. They'd rather do just about anything than public speak. So if they know each other a little bit better it is not such an intimidating process. Actually this semester, well, when I wrote the schedule I thought that we were going to have a traditional final, so that presentation day might actually get bumped back a day and it looks like I might be able to take the kids on a field trip to Callaway fields here in town. They are rebuilding and relocating so I'm hoping that I can working something out with them so that we can go when the weather gets a little nicer (side conversation about the weather)</p> <p>Meg – So that's kinda, I build all my classes with those three overarching principles and then kind of, with each class, with non-majors especially that engagement piece. Making science not so scary, that's really what I'm after to.</p>	<p>Practice - presentations</p> <p>Shy students</p> <p>Make science not so scary and engaging</p>
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CHAPTER 3

Adaptability or consistency in assessment: Personal practical theories and practice of community college science instructors

INTRODUCTION

Assessment is an important topic in international science education reform because it influences all parts of instruction (NRC, 2001; DOE, 2000; Millar & Osborne, 1998). It can be used by science instructors to help students learn (e.g. formative assessment, Black & Wiliam, 1998; NRC, 2001) or to evaluate the effectiveness of instruction and assign a grade (e.g. summative assessments, NRC, 2001; Shepard, 2000). While often studied in the K12 classroom context via self-reported surveys, assessment practices and beliefs need to be studied in more detail within the context of an individual course because this will reveal more nuanced differences for education reform efforts. Assessment practices are also widely variable in community colleges, also known as junior colleges, which rely on minimally trained adjunct instructors to teach many of their courses (Hardy and Katsinas, 2007).

Frequently overlooked in the research literature is the instruction and assessment of rural community college students. Internationally, there is increased interest in serving students in rural communities to promote equitable access to quality science instruction (Lyons, Choi, & McPhan, 2009). Urban community colleges have been at the center of education research because the diversity of their population, but a new call has been made to also consider rural community colleges and their unique context challenges (Katsinas & Hardy, 2012; Schinske et al., 2017). Community colleges represent an important gateway for first-generation, rural college students who might later transfer to a four-year university to complete their

degree program (Dowd, 2007). A recent U.S. biology education task force issued a call for action which recognized the importance of research into education at the community college level. It stated that the faculty who teach these students stand to “provide unique practical insights and motivation to understanding biology teaching and learning” (Schinske et al., 2017, p4).

While research has begun exploring assessment practices and beliefs of instructors at community colleges through broad survey methods (Huber, 1998; Lei, 2008; BoarerPitchford, 2014; Keller, 2017), relatively little work has studied the assessment practices of community college science instructors. Further, previous studies have found contrasting assessment practices of community college instructors with some instructors focusing primarily on objective exams of content knowledge (Lei, 2008) and others more likely to use research papers and projects to assess critical thinking (BoarerPitchford, 2014). More research is needed to characterize and describe rural community college assessment practices to better inform science instructional decisions across all levels of instruction. In this study, I examined the assessment beliefs and practices of three experienced community college instructors within the context of their rural biology classrooms. More specifically I asked:

1. What personal practical assessment theories (PPATs) do participating community college instructors have when teaching an introductory biology course?
2. How do these PPATs manifest in the assessment practices of participating community college instructors?

THOERETICAL FRAMEWORK AND BACKGROUND LITERATURE

Assessment development model

The assessment development model (Box, Skoogs, & Dabbs, 2015) was used as the framework for this study. The foundation of this model is the instructor's PPATs, which are a group of beliefs influenced by past experiences (personal) and previous classroom experiences (practical) (Cornett, 1990; Box, Skoogs & Dabbs, 2015). This framework was originally described by Cornett, Yeotis and Twillinger (1990) and it was widely used in the K12 science education context to examine teacher beliefs (Levin, He, & Allen, 2013; Ritchie, 1998; Sweeney, 2003). Many of these studies, though, fail to also consider the practices and contextual influences on beliefs by instead focusing on just PPATs (Maaranen et al., 2016; Männikkö & Husu, 2019). Personal practical theories related to overall instruction have been found to change over time as personal and contextual factors change (Levin et al., 2013; Sweeney, 2003; Cornett, 1990). Box et al. (2015) adapted Cornett, Yeotis and Twillinger's (1990) original model to consider the assessment beliefs (PPATs) and practices used by instructors.

An instructor's PPATs influence or are influenced by every portion of the assessment development model. In this cyclical model, an instructor's ideas about the purpose of assessment influence their assessment planning and are connected to their PPATs (Box et al., 2015). An instructor's purposes for assessment might range from providing motivation to providing a learning experience for students. In turn, this purpose and PPATs affect the planning of assessments. When instructors implement their planned assessments, they make important classroom decisions in practice regarding how and when to use the assessment in the classroom. Lastly, the instructor might reflect on the outcomes of assessments that are administered in the classroom. The results of those assessments can continue through the

assessment cycle to influence or reinforce planning and goal-setting for future assessments. It has been shown that not all instructors will complete the full cycle; in many instances, they leave out the final reflection portion of the assessment development model (Box et al., 2015). Finally, it is important to note that as an instructor continues to practice assessment, those experiences can, in turn, affect and change PPATs, though this has not been studied in depth over the long term (Levin et al., 2013).

College instructors' assessment beliefs and practices

Previous research at the K12 level has shown that instructors' beliefs about assessment are influenced by their personal experiences (Ritchie, 1998). For example, one elementary instructor manifested his belief in promoting student independence through informal questioning of students' progress with the content (Ritchie, 1998). This stemmed from the instructor's military experience. It is also important to note that K12 instructors' PPATs can be multifactorial, including the importance of assessment variety, authenticity of task, value given to planning assessments, and adaptability to meeting students' needs (Levin & He, 2008; Levin et al., 2013). There is also evidence that instructors will alter their assessments based upon reflection of their assessments' effectiveness, which leads to a change in their future planning and assessment practices (Sweeney, 2003).

Few studies have been conducted specifically examining the PPATs of post-secondary instructors, but previous beliefs research describes how community college instructors place a high value on teaching and on the assessment of skills rather than on content knowledge (Huber, 1998). When course content is taken into consideration, instructors such as chemistry faculty have been found to believe that assessment should focus on conceptual understanding

and reasoning skills rather than on oral or written skills (Slavings, Cochran, & Bowen, 1997). More recently, nursing instructors expressed assessment beliefs that also focused on content knowledge gains rather than on skills or on helping students learn (Schaefer & Zygmunt, 2003). Thus, it appears that course content is an important contextual element that should be taken into consideration when discussing a science instructor's beliefs about assessment.

Historically, post-secondary assessment planning has been categorized as being of little value to instructors, who spent 90% of their class time on other instruction-related practices, such as lecturing or laboratory activities, rather than on assessment (Slavings et al., 1997). More recently, a U.S. reform document has called for more student-centered instruction, which promotes less instructor-focused lecturing and more use of varied assessments (AAAS, 2011). Specifically, this reform document suggested that instructors should use varied assessments, which provide many instances for students to receive feedback on their learning throughout a course. Such assessments also provide clear learning outcomes around which all instructional activities are constructed (AAAS, 2011). International reform documents state similar goals of reforming education to include more formative assessment and student-centered, adaptable instruction (OECD, 2008).

This reform has been reflected in community college instructors' assessment practices. They now use more varied assessments, including student questioning strategies such as clicker questions, to scaffold learning (Holme et al., 2010; Keller, 2017; Skinner, 2009). For example, instructors at one community college added additional formative assessments focused on developing students' microscopy skills (Keller, 2017). This supported their diverse and academically challenged students, who traditionally struggled with this skill needed for future

courses in their discipline (Keller, 2017). These studies have found there are an increased variety of assessment formats in use. This deviates from the traditional assessment strategy of three exams and a research paper found in many post-secondary college science classes.

Broader surveys have found conflicting assessment practices of community college instructors. Across all disciplines, BoarerPitchford's (2014) survey study found that at two suburban community colleges, instructors added more authentic assessment, which accounted for over 90% of students' grades. The author's definition of authentic assessment posited that the instructors valued having students use more critical thinking while solving problems. They valued students explaining content within scenarios rather than taking multiple choice exams solely focused on content understanding outside of an authentic scenario. In contrast, Lei (2008) found in a self-reported survey that suburban community college faculty were most likely to report using objective exams for assessment purposes in their classes. The other common assessment practices were research projects and papers and online assessments (Lei, 2008). There is a disparity between these two larger survey studies, lack of reliability among self-reported survey practice data (Henderson, 2008), and a risk that instructional beliefs and practices are content dependent. Thus, the goal of this study was to examine the assessment beliefs and practices of three experienced community college instructors within the context of their rural biology classrooms with the assessment development model framework.

METHODS

Research Design

To describe the individual participants and experiences within their unique context, a multiple case study design was used (Yin, 1994). Case participants were carefully selected. All

participants were full-time, community college biology instructors with more than seven years of teaching experience, the typical college tenure time. For this study, a snowball sampling method was used. I first recruited an instructor whom I already knew, and she connected me to other faculty who fit my criteria. The cases were bound within a single introductory biology course for a single semester of study.

Participants

The 3 participant instructors’ background information and instructional context are described in Table 3.1. All of the community colleges were located in rural Midwestern towns with less than 20,000 residents and were farther than 30 minutes away from any major city with more than 50,000 residents. The names of all instructors and colleges names are pseudonyms to protect privacy.

Table 3.1: Case Participant Characteristics

	Meg	Jane	Richard
College	Northbend 183 students	Southview 600 students	Eastside 2,300 students
Teaching experience	15 years	12 years	26 years
Course Name	Introduction to Plant Biology	Microbiology for Allied Health	Microbiology for Allied Health
Type of course	Elective	Required	Required
Number of Students	9	10	19
Semester of study	Spring 18	Summer 18	Spring 18
Hours of Observation	6	6	6
Course structure	Lab/Lecture (3 hours; 1 day a week) Hybrid	Lab/Lecture (3 hours; 4 days a week)	Lab/Lecture (3 hours; 2 days a week)

Meg is a biology instructor at a satellite campus located in a small, rural community with around 180 enrolled students. During the Spring 2018 semester, Meg was observed teaching introductory plant biology, which had nine students and was a course for non-science majors. Students take the course for lab credit. This was the first time Meg had taught this course in five years. It is a hybrid course with online and face-to-face components. Jane is a full-time biology instructor at a satellite campus with approximately 600 enrolled students. Jane taught Microbiology for Allied Health, a course required for nursing majors, during the Summer 2018 semester and had 10 students enrolled. Jane has taught this course for the past 12 years since she was hired at the college. Finally, Richard is a biology instructor at the main campus of a community college located in a rural town. The course observed in Spring 2018 for this study was the Microbiology for Allied Health course. His course had 19 students enrolled for the semester of study, and he had been teaching this course for 26 years.

Data Collection

Case study data were collected in the following semesters: Spring 2018 for Meg and Richard and Summer 2018 for Jane. Data were collected at intervals throughout the semester, including the middle and end of the course. After the semester was completed, the data also included correspondence with the instructors about any changes that they made to the course at the end of the semester or that they planned to make the following semester. Both primary and secondary data sources were collected for this study. Primary data sources included instructor interviews, impromptu discussions and observations. Secondary data sources included any artifacts collected from the course (e.g. exams, homework, online quizzes, etc.) and course syllabi.

More than six hours of classroom observation fieldnotes (CO) were collected for each case study participant to describe assessments observed in practice as well as direct feedback given by the instructor to students following an assessment activity. This was the result of two classroom visits per instructor. The observations were audio recorded to aid with transcription of instructor and student interactions. Instructors' practices were also informed by the secondary data sources, which included course artifacts such as homework, online assessments and course syllabi for the class sessions observed. Meg and Jane both volunteered to share their most recent exams for the study, too.

Instructor interviews included at least two, audio-recorded, formal interviews around the time of observation: pre-observation (PreObs) and post-observation (PostObs). More specifically, Meg performed two PreObs interviews, once before each observation, while Richard and Jane only did one before the first observation. Before the class observations, the instructors were asked to explain more about their teaching beliefs and plans for the upcoming class period. Sample questions included: *How do you define assessments? What do you believe is the goal of assessment?; Describe your assessments plans for this unit.; If you were unlimited by time, resources, etc., how would you modify your assessments?*

Within a week of observation, each instructor was asked to reflect on the assessments used during the observed class period as part of an audio-recorded post-observation interview (PostObs). More specifically, Meg completed the post-observation interviews the day following each of the two observations while Jane and Richard completed a single post-observation interview four and five days after the second observation, respectively. Sample questions

included: *What did you feel went particularly well? Is there anything you would have done differently?*

Data Analysis

The primary data sources were coded drawing from the assessment development model components to identify and support inductively derived PPATs for each instructor. Briefly, each interview transcript was coded by line citing evidence for each of the components of the model such as beliefs (PPATs), purpose, plan, practice and reflection. For example, when an instructor described how they viewed the successfulness of an in-class assessment used, this was characterized as an instance of reflection on practice. For example interview coding, see Appendix A.

Once the interview data were coded, detailed practice evidence was drawn from the observation fieldnotes and supported by the secondary data sources. Throughout the coding process, memos were used to collect the researcher's thoughts and ideas about the overall summary PPAT statements for each instructor. Up to four PPATs were inductively determined for each instructor following the first round of data coding by grouping all interview quotes categorized as beliefs statements. Following identification of draft PPAT statements, evidence from the primary data was sorted and connected to each set of beliefs. This sorting led to refining and condensing of the PPAT statements into only two statements for each instructor. Finally, the data were used to compose a case narrative. This demonstrates how the primary data supported the PPATs derived for each instructor. This allowed for further validation of the PPAT results and triangulation across the data sources (Merriam, 2009).

To ensure proper validation, member checking occurred (Merriam, 2009). Each instructor received a copy of his or her case narrative and had the opportunity to offer any suggestions or clarifications. No major changes were suggested by any of the instructors following the member check. A second researcher who is familiar with the assessment development model also reviewed all data sets, memos and conclusions derived to further validate the study's findings (Creswell, 2012). The second reviewer contributed some helpful advice for rewording two of the PPATs for clarity and reached a consensus with the first author about the conclusions drawn from the case study data. Finally, a cross-case analysis was performed to find similarities and differences among the participants' assessment development models to make generalizable claims (Yin, 1994). Practices and beliefs were directly compared across all three participants.

RESULTS

Overall, there was a consensus among participants that assessments are an important component of instructional planning for teaching students and evaluating their learning. Although polished assessments were considered necessary by all of the instructors, Richard did not think it was important to adapt assessments regularly or within a semester. The data also revealed that there was some variation in whether instructors assessed content or skills. For this analysis, I will first describe and compare the instructors' PPATs. Then I will connect these PPATs to their manifestation in practice structured within the assessment development cycle. The comparisons are visualized in Table 3.2.

Table 3.2: Cross-Case comparison of instructors' assessment beliefs and practices

Assessment Beliefs	Meg	Jane	Richard
PPAT1: Assessment is for...	Student learning and practicing skills while exposing them to content	Evaluating student learning of concepts	Evaluating and teaching students specific content knowledge
PPAT2: Assessment should be...	Varied and adaptable to allow students to show growth in knowledge and skills	Varied and adaptable to promote student learning and engagement with the content.	Structured and consistent so students know what is expected of them.
Summative Assmt Practices			
Lecture Exams	Take home, every 2 weeks, written and multiple choice; cumulative final	Three exams, multiple choice; cumulative final	Three exams, multiple choice; cumulative final
Laboratory Exams	Practical	Midterm, Final – practical and written components	Midterm, Final – practical and written components
Quizzes	Online quizzes – two chances	Group and individual quizzes in class; online quizzes	Individual quizzes in lecture
Research Paper	Plant of Interest – multiple drafts	Organism of interest – multiple drafts	Organism of interest – single draft
Semester Project	Group Experiment	--	Organism list
Online discussions	Bi-weekly online discussions	Organism list and hmwk discussions	--
Homework	Written	Written	Written
Laboratory Reports	Adaptable, activity-based worksheets to connect lab to lecture content	Structured, included guiding questions; independent of lecture content	Structured, included guiding questions; independent of lecture content
Formative Assmt Practices			
Lecture Assessment Activities	Often – whiteboard activities, instructor questions	Often - Clicker questions, whiteboard activities, questions	Rare – instructor questions
Laboratory Assessment Activities	Individual and group questions	Individual and group questions	Individual and group questions, structured whiteboard activities
Impromptu in class questions to...	Check understanding	Check understanding	Check student engagement

RQ1: What personal practical assessment theories (PPATs) do participating community college instructors have when teaching an introductory biology course?

There were two main categories of PPATs identified for each instructor studied. First, the instructor's beliefs about the purpose of the assessment and the structure and adaptability of assessments were summarized into a single statement. Using evidence to support these summarized sets of beliefs for each instructor, I then compared beliefs across all participants.

The first PPAT related to each instructor's beliefs about the purpose of assessments. Meg, a plant biology instructor, held a self-reported belief that assessment should be designed to allow students to practice and learn new skills while being exposed to the content. She stated that,

I'm not super aimed at the content necessarily in that class, so I'm looking more for skill development, writing skills ... along with more knowledge-based critical thinking, and helping them to become better writers and speakers. Doing assessment where they are forced to do those sorts of activities and get feedback (PostObs2 p2).

Although Meg focused on skill assessment, she also supported the belief that students could learn and practice these skills while learning the content. Therefore, Meg did not sacrifice content learning goals for skill learning but saw both of these learning gains as compatible and important.

In contrast, both Richard and Jane professed a belief that assessment should be used for evaluating student understanding of concepts covered in their course. For instance, Jane explained that her goal of assessment was to,

see if they are learning it, to see if they get it. If they freeze up, then clearly they don't understand it as much as I thought because all of those things I do when I feel like, 'OK, we are done talking about this.' You've a little bit to digest it, and I feel like you should know what you are doing. If it is a disaster, [then] clearly I am wrong. Then we go back and talk about something else a little bit more (PostObs1 p3).

Thus, Jane used her own judgement of student reactions to make instructional decisions aimed at student understanding of the content. Richard put forth similar beliefs in that his lecture quizzes and exams were designed to objectively evaluate student learning of the content goals for his course (PreObs). As the content goals directly mirrored the chapters in the textbook, Richard's assessment goals centered on evaluating microbiology concepts, which he saw as integral for their future role as nurses (PreObs).

The second PPAT related to each of the instructors' beliefs about how assessment should be structured and how assessments should function. In this instance, both Jane and Meg held strong beliefs that assessment should be both varied and adaptable to the current student population's interests and understanding. Meg described her adaptability, noting assessments allow for students to show skills growth in various ways. She said,

I want students to have as many opportunities as possible to show that they are improving. Because that is what I think school is really about. It's not necessarily that you are going to be perfect at every assignment but improving as you go. With few assessments, it is hard to tell if students have been improving, so I like to give lots of those" (PosbObs2 p3).

Jane was also adamant about variability, and she reasoned that this allowed students to learn in different ways and helped students to stay engaged with the content. She described it as, “different people like different things. And probably different people will remember whatever from different ways of doing it” (PostObs1 p6). Jane also noted that the varied assessments allowed students to have multiple chances to be exposed to the content and therefore more chances to learn through repetition. She explained “usually by the fourth time, they get it ... then they just keep seeing it, and eventually they usually get it” (PostObs1 p2).

Both Jane and Meg believed that assessments should be adaptable within the semester to meet their goals of student learning, growth and engagement. In this instance, Jane described how she would change her assessments within the semester depending on how students performed on assessments such as concept maps versus writing assignments (PostObs). In a similar manner, Meg was adaptable in her assessments within a semester to allow room for reflection about the purpose of the assessment. She explained, “I think it forces you to kind of think about what you want students to know, what’s the important things” (PostObs2 p4).

Finally, Richard’s beliefs about assessment structure were distinct from the other two participants in that he believed that assessment should be both highly structured and consistent so that students know what is expected of them. For instance, Richard explained, “Once you have, I’d say two or three semesters under your belt, then it is easy to use the same material over and over again” (PreObs1 p6). When planning assessments, Richard discussed how he was pleased with the current assessments, as students seemed pleased with his course so there was no need to adapt. Richard’s beliefs about structuring assessments stemmed from

previous experiences with students plagiarizing, which he believed did not lead to learning (PreObs p3). Therefore, he believed that by using highly structured assessments, students would be less likely to copy information from other sources.

Thus, each of the instructors' beliefs about assessment were unique but overlapped with others. Meg professed that skill goals were more important than content, while Jane and Richard prioritized content goals above evaluation of skills. Jane's goals of being adaptable and having variable assessments more closely aligned with Meg's goals of variability to allow students to show growth. Richard's assessment beliefs were strongly rooted in providing his students with structure and consistency. It is interesting to note that Richard's and Meg's assessment beliefs did not overlap for either of the beliefs identified while Jane's beliefs intersected with both Richard and Meg's.

RQ2: How do these PPATs manifest in the assessment practices of participating community college instructors?

When the primary data were analyzed through the lens of the assessment development framework, it became evident that for each of the PPATs identified above, the instructors clearly purposed, planned and practiced assessment in a way that was consistent with their identified beliefs. Alternately, not every instructor studied showed various levels of reflection as part of their resulting assessment development model. Below, I provide examples of how the instructors manifested their PPATs through their assessment practices.

Manifestations of PPATs: Summative assessment practices

The instructors' practices involving summative assessments were very similar. These structured assessments were typically scored and evaluated for a grade. Meg exhibited her

belief in the importance of writing, speaking and critical thinking skill development when planning her course assessments. These included a group semester-long experiment, a research paper, laboratory reports and presentations (Syllabus, Obs). For example, the semester-long group project was aimed at evaluating and developing critical thinking skills. Her students worked in small groups to design, collect data and report on an original research project. “So they’ve each designed their own experiment and come up with their own hypothesis, and they are actually carrying it out. ... I really like that they will probably fail a few times, and I think that is really important” (PreObs1 p3). Meg pointed out that the students might fail, which she felt would cause them to spend more time thinking critically about ways that they can improve or fix their problems.

At the beginning of the semester, Meg worried that students would all get As and Bs on her take-home exam. But she found that was not the case for many students who still struggled despite the open-note nature of the exams (PostObs1). Before the final observation late in the semester, Meg described how she had revised her take-home exams to include a practical in-class component. She observed,

they were doing dichotomous keys, and I was like, ‘That is just kinda perfect.’ We did it in lab and practiced, so they practiced with leaves, and then I gave them seeds at the beginning of class, and they had to work through. It gave them something a bit more practical (PreObs2 p2).

The bi-weekly take-home exams included multiple-choice questions and also short answers, which Meg explained as, “so I kind of try to counteract the amount of multiple choice that I do with ‘OK, here, write and think a little bit, too’” (PostObs2 p4). Thus, Meg not only used

assessment consistent with her beliefs about skill building but also showed reflection leading to adaptation of her assessments to foster these skills further. This example also showed a clear instance of Meg's two PPATs overlapping to foster skill development and her belief in adaptability.

Richard and Jane also included written assignments within their course, but not with the same express purpose as Meg. This aligned with their differing PPATs. Richard's research paper had the goal of exposing students to medically important microorganisms (CO1). Richard's requirements for this research paper, along with another writing assignment called the organism list, were highly structured and specific consistent with his second PPAT. Richard even provided students with an electronic template for the organism list (CO2). Students filled in the template so they did not miss any of the required information. Richard explained the goal of this activity was to not only allow students to learn about these organisms but also to help them learn how to look up the information (PostObs2). He described it as,

They are going to go out there and are gonna be nurses. When they read the name of some microorganisms on someone's chart, at least if they have been introduced to it, they are not going to say, 'Huh, I wonder what that is?' (PostObs2 p3).

Upon reflection, Richard only modified these types of assignments between semesters rather than within them by decreasing the number of organisms included to allow students more time to work on the longer research paper.

Similarly, Jane assigned an organism of interest research paper. Hers, though, was geared instead toward working with students to understand how to interpret scientific readings and paraphrase material (PreObs1). She adapted the same organism list assignment Richard

used for use in an online discussion board. This allowed students to explain the information to their classmates and share their learning with others (PostObs1). In contrast, Jane relied heavily on quizzes and in-class activities to assess her students' understanding of the content. In practice, Jane gave her students a short quiz, asking them to fill in a concept map about gram staining (CO2). She reflected during the post-observation interview that it was clear, as she was circulating the room, that the students were understanding it and finishing the quiz quickly. She concluded that they understood the gram staining procedure (PostObs1). Consistent with her PPAT2, Jane put forth that she would not have used future concept mapping assignments if the students did not seem to like concept maps (PostObs1).

Manifestations of PPATs: Formative assessment practices

All three instructors used forms of formative assessments, which did not result in class points. Consistent with her PPATs of adaptability, Jane used ungraded clicker questions during her lectures. Students were given a notecard with letter answers to questions. She would then embed these questions into her PowerPoint lectures to test student understanding of the content she had just covered (CO2). She described the goal as not only an evaluation but also a learning opportunity. She explained,

I had two questions in a row, they were kind of the same questions, just with different math. And I have had good success because the first one they don't get, and we have to talk through the whole thing, and then the second one most of them get, and then the third one they all get (PostObs1 p5).

Meg also included impromptu questions within her lectures to check student understanding (CO1). Observed formative questions were less structured than Jane's, though, in that she

asked students to connect the content to concepts from previous chapter or to real-life examples, such as those found in the grocery store or in agriculture (CO1).

Richard had a different motive to include questions within his lecture which was inconsistent with the definition of formative assessments. He wanted to make sure students were engaged rather than check understanding (CO2). He described the question's purpose as "a pulse-check" (PostObs2). Thus, Richard did not use the assessment results to inform his course structure or future assessment strategies within the semester, showing that he did not engage in the reflection portion of the assessment development model. Instead, Richard's class was so polished and practiced that he felt that he did not need to plan or include understanding questions within his lectures to check student comprehension or to find out if they were learning the material (PostObs1 p6). The few questions Richard was observed asking resulted in no student knowing the answer to the content question. This prompted Richard to explain to the students that they needed to know and remember the concept for the next test. Rather than providing a formative reply, he did not go back and explain the concept (CO2).

Consistent with his PPAT2 regarding structure and consistency, Richard also chose to use structured whiteboard activities within the laboratory section of the course to help walk the students through the analysis of their results as a class (CO1). In this assessment, he had each laboratory group put their results into a table projected on the whiteboard. Then, in front of the class, Richard walked students through the analysis and conclusions that could be drawn from the results. In this way, he was able to make sure the students came to the conceptually correct conclusions about which antibiotics would work on each bacterium tested.

In contrast, both Meg and Jane's practice supported their use of adaptable assessments. They modified their assessments and instruction within the semester, as well as between semesters, in a manner consistent with their PPATs. Meg originally began the semester spending the first half of the class lecturing students about the content. But by the end of observations, Meg had instead started expanding the laboratory assignment to include activities and questions, which the students had to answer in groups using printed PowerPoint slides (PreObs2). She noted that students' learning was benefiting from the change. Meg stated, "So by giving them the more hands-on things, I'm hoping that helped them learn more than we would have if I continued to sit here talking to them and them not paying any attention to me" (PostObs2 p7). She also added homework to the laboratory assignments so they would continue to engage with the content (PostObs2 p6).

In a similar but less extreme manner than discontinuing lectures, Jane was also adaptable with her assessments. If Jane saw that her students were not completing or enjoying the assessments, she would change the type of assessment used (PostObs1). Over time, Jane had built up a repertoire of assessments for each section of her course. She could pick and choose from among them based on students' performance or desires during the semester (CO2). She described one semester in which students never turned in homework assignments. In that case, she stopped assigning homework (PreObs1). In the semester of study, she noted that students were good at working in groups, so she assigned more group quizzes and assignments and less independent work (PostObs1).

Overall, every instructor exhibited purpose, planning, practices and reflection that aligned with the PPATs described. It was important to note that while Richard did not include

assessment reflection related to his PPAT of structure and consistency, this lack of action still aligns with his PPATs because including variability is directly in contrast with his beliefs. Jane and Meg clearly showed how they reflected on the results of their assessment. In turn, they changed their practice, yet their goals for their assessments remained the same. Jane wanted students to learn content in an engaging way, while Meg was more focused on student learning of skills along with content.

DISCUSSION

Situated within the assessment development model, the results of this study suggested that an instructor's beliefs can have an effect on their use of reflective practices. A greater influence of instructors' beliefs or PPATs is usually placed on the purposes portion of assessment development cycle (Box et al., 2015). Our study agreed that beliefs about the purpose of assessment are important in that each instructor discussed a single PPAT directly related to this. Meg believed that students' skills development was the purpose of assessment, while Jane and Richard primarily designed assessment to evaluate student content knowledge. These beliefs were manifested in their planning and practices. Richard used mostly summative assessments aimed at assessing content knowledge which was common among community college instructors in previous studies (Schaefer & Zygmunt, 2003). Consistent with her beliefs, Meg planned and used projects that allowed students to practice skills such as critical thinking and writing. This approach is becoming more common in community college instruction (BoarerPitchford, 2014).

Although often overlooked in PPAT studies, the reflection portion of the assessment development model seemed also to manifest consistently with the instructors' beliefs,

according to our findings. Previous studies noted that instructors can fail to complete the cycle of reflection because of contextual constraints rather than instructor beliefs (Box et al., 2015). The results of this study of experienced instructors at the community college level challenge this notion. Instead, we observed that instructors such as Richard did not complete the reflection portion of the assessment development cycle because he held a belief that consistency was important. Consistency can sometimes be considered an external contextual element in some cases (Birt et al., 2018, under review). But that was not the case in this instance. It is not a requirement imposed by the college, as evidenced by the practices of Jane, who taught the same course in the same college. Jane and Meg both actively showed their use of reflective thinking to adapt and modify their assessments. Thus, it can be noted that when using the assessment development model to analyze instructors' beliefs and practices, it is important to consider and probe an instructor's beliefs about consistency and variability.

It is also interesting to note as part of the assessment development cycle that the cyclic influence of instructor reflection on purposes of later assessments somewhat misrepresents the connection between the two assessment elements portrayed in this study. For example, when Jane's assessment did not show content gains, she changed her practices rather than her purpose for the assessment. Her purpose of assessment—to help students learn the content—did not change. Rather, the assessment acted as an evaluative measure to help her make decisions about adapting assessments in the future. Therefore, a clearer connection between the reflection portion, viewed through the lens of instructors' PPATs, should connect reflection with the planning or practice part of the assessment development cycle. Overall, in this study, the assessment development model worked well to separate the instructors' PPATs and

practices into clearly recognizable steps. The assessment development models described above can serve as important comparative examples for future studies into community college instructors' assessment practices and beliefs.

CONCLUSION

Community college science instructors stand at an important gateway for college students, as 50% of college students attend community colleges (Dowd, 2007; Katsinas and Hardy, 2012). Although research into community college instructors' practices and beliefs has increased, few studies have focused directly on individual instructors; instead, studies that have been conducted have used broad survey methods (Lei, 2008; Keller, 2017). Giving attention to individual instructors allows researchers to uncover a greater level of detail and focus on the variation among instructors' beliefs and practices. Thus, this study lays a foundation for future assessment beliefs studies and application of the assessment development model to the community college science classroom. Overall, I found that community college instructors have varied beliefs about the purpose of assessment, such as evaluating content understanding or skills growth, as well as about the amount of variability needed in assessments. These findings have implications for both professional developers and science education researchers.

First, professional developers working with college science instructors should help instructors recognize their beliefs about assessment before attempting to mediate reform efforts. It has been previously shown that K12 science teachers are more likely to modify their instructional practices if they participate in activities that allow them to carefully consider their beliefs and goals for assessments (Sweeney, 2003). I suggest that similar gains in assessment development would be realized for community college instructors' practices if they were asked

to reflect on their previous assessment practices and identify their own PPATs. Instructors are unlikely to use assessments that are contrary to their beliefs no matter how heavily they are promoted (Witzig et al., 2010). In turn, if professional developers are made aware of an instructor's beliefs, they can introduce assessment methods to the instructor in ways that align with the instructor's beliefs rather than trying to modify his or her beliefs.

Second, researchers should be aware that assessment beliefs may vary. They may become more rigid as instructors gain experience. Recent research suggests that more experienced teachers become more student-centered as their personal practical theories change (Levin et al., 2013). In contrast, this study's results found that the most experienced instructor had the least student-centered perspective; he believed that consistency was more important than adapting his course each semester to his students. Consistency among sections of courses is a common theme in college instruction to allow for similar experiences for all students, but it can act as a barrier to reform efforts (Birt et al., 2018, under review). In contrast, Meg and Jane, who had taught for fewer years than Richard, were more adaptable and willing to adjust their assessments and instruction following summative and formative assessments. Although the small number of participants in this study hinders any direct conclusions about how experience level affects assessment beliefs, it is logical to think that as similar personal and practical experiences increase, the PPATs become less adaptable.

These findings are an important starting point for further studies into professional development or workshops that seek to help instructors reflect on their assessment practices. This line of research fills a crucial need to understand the types of practices and beliefs of community college instructors. This will not only inform professional development efforts but

also inform university college instruction. As noted in the taskforce call for action by Schinske and colleagues (2017), practices used by community college instructors play an important role in educating many students who later transfer to a university. Experienced community college science instructors, such as the three included in this study, have many untapped insights into teaching students. These insights can inform science instruction at the two-year level and help to ease students' transition into four-year institutions (Schinske et al., 2017).

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APPENDIX A

Meg – Post Observation Interview 2

Data Analysis Below for Manuscript #2 RQ1: What personal practical assessment theories (PPATs) do participating community college instructors have when teaching an introductory biology course? And RQ2: In what ways do these PPATs manifest in practice?

PPT/Beliefs Assessment Practices Affordances Hindrances Reflections

<p>JB – So the main thing, and I meant to ask you this before class the other day. So what are your views about assessment in general. My question is how would you define assessment? What are it's purposes and goals in your classroom?</p>	<p>PPT – purpose of assessment</p>
<p>Meg – Um so I think assessment serves two main purposes in the classroom because I think there are two types right. So when I think of informal assessment and formal assessment. Informal assessments are those questions that you ask in class. I want to start doing more with Kahoot and things like that.</p>	
<p>JB – is that like using your phone?</p>	
<p>Meg – Yeah for more informal assessment. Especially in my upper level classes where retention is a little bit more important than necessarily in the intro classes. During lab you know kind of asking them questions. Activities that we do together, those sorts of things. So those are more, the purpose of those is more to get a feel of where the students are and where their confusion is and being able to fix those things in the moment more. And then I think formal assessment is more to judge kind of their overall understanding and especially the progression of their critical thinking skills over time. So from the beginning of the semester to the end. So especially in the class you have been watching, I'm not super aimed at the content necessarily in that class, so I'm looking more for those skill development, writing skills, those sorts of things. And then you know kind of along with more knowledge-based critical thinking helping them to become better writers and speakers so doing assessment where they are forced to do those sorts of activities and get feedback. And I think any assessment if the more feedback you can give them, the more opportunities you give them to revise and improve, the better the outcome. So that was a circular answer to your question. Did that answer your question?</p>	<p>Assessment practice PPT - purpose PPT – formal assessment -> change over time Focused on skill building and knowledge to support those skills PPT – feedback to students is important</p>
<p>JB – Yeah sure, it was a great amount of detail. You mentioned retention for your other classes. What do you mean by that?</p>	
<p>Meg – So those are not terminal classes. So those are classes where the knowledge is supposed to go with them, and so that has always been one of my bigger frustrations. Because I see students typically, for three semesters especially our allied health students, maybe not consecutively but that is typical is to see them three semesters in a row. So they do</p>	

<p>anatomy, then physiology, and then microbiology and I always feel like in physiology especially there are some areas in anatomy, I don't expect them to retain all of it, but there are some key things that they don't retain, or then it kind of scrolls over in microbiology that there are things from physiology that they don't seem to retain and then you go on to other classes and then you are worried that people are like 'well, did she teach that'. So that's more whereas the bio and the plant biology for the most part students are there more for the overall science so that they are good concerned citizens. So the knowledge isn't necessarily, the principles are more important right than the actual like do you remember what the renal angiotensin system is. You know when you go to nursing school because you are going to use it a bazillion times. So that is always on my radar but it is hard to judge because they may do well on the material but then you feel like the next semester you are starting over again.</p> <p>JB – Well that is too bad, it is interesting that the students' aren't retaining it.</p> <p>Meg – And that's not true of all students but you know there just seem to be certain concepts that just seem to gaps that the majority of students have so you know that material has been covered in multiple ways.</p> <p>JB – So do you ever adjust your instruction based on later semesters of having these students? Like in the earlier?</p> <p>Meg – To a certain, I think that especially in anatomy I have probably pared down the material in hopes that, and I think that is true of new instructors, and it was true of me, you are so excited and you want them to learn all the material. And then you come and start to learn that if you throw so much at them that they don't retain any of it. So that is probably the one thing that I have done that has been the most successful is that to try and really hit those specific things and then I hit them again on the final. So like in anatomy, so all of our finals are supposed to be cumulative or at least have a cumulative component to them, I know a lot of instructors don't look at that and then go on with their lives but, I've always thought that there was some benefit for that. So in anatomy particularly I have a group of information that I think students should leave anatomy with so that forces them to go back and look at it. So that is one thing I have really done. I'm sure there are other things I could do but finding time to implement them can be challenging.</p>	<p>PPT – doesn't expect full retention but knows knowledge builds Purpose – course purpose -> Informed citizens; knowledge not necessary</p> <p>Revision – pared down the content</p> <p>Practice – cumulative final</p> <p>PPT – cumulative final forces students to review important material</p>
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CHAPTER 4

Reaching rural students: CARE principles to promote student engagement in college biology courses.

INTRODUCTION

In the current political climate, many people place little value on scientific evidence in decision-making. This means the science education of rural students is increasingly important. It represents an opportunity to equip future leaders with greater scientific literacy. Although more than 30% of all community college students have a rural background, they are rarely the subject of science education research (Katsinas & Hardy, 2012). This is slowly changing as researchers recognize the value and strength of rural residents' political viewpoints as evidenced in the 2016 election cycle. Belkin (2017) described how university members were blindsided by the results of that year's presidential election. He labeled this as a rural reckoning that occurred in part because not enough rural students' views were present on university campuses. Thus, many universities are now actively working to recruit rural students to their campuses. This will help ensure the ideas of students with low socioeconomic background and politically conservative ideas are represented.

Rural community colleges can be described in various ways, so it is important to clearly define rural when discussing rural-specific education research (Howley, Howley, & Yahn, 2014). For our purposes, a rural community college is a two-year college that has fewer than 2,500 students enrolled at a single campus location. The campus must be located in a town with fewer than 50,000 residents. It must be more than 30 minutes away from a metropolitan center of more than 50,000 residents.

Table 4.1: Characterizing Rural Community College Students

Characteristic	Description	Source
Family	Rural students have strong family ties which can be both supportive and a hindrance.	Bers & Schuetz, 2014
	Parental support of education is common	Hlinka, Mobelini & Giltner, 2015
Community	Rural students typically plan to stay in their home community upon degree completion	Katsinas & Hardy, 2012
Commuter	The average commute is 52 miles.	Hillman, 2016
Work	79% of community college students are employed at least part-time	NCES, 2017
K12 Education	Rural students' parents value education and are actively involved in their children's schools	Hlinka, Mobelini & Giltner, 2015
	Weaker tax base for rural K12 schools thus fewer resources.	Silverman, 2014
Socioeconomic Status	62% of students qualify for needs based federal college assistance such as Pell Grants.	NCES, 2017

Rural community college students have unique characteristics from their urban counterparts. For instance, they might commute about 50 miles rather than live on campus (Hillman, 2016). Thus, rural students often have less freedom in school choice. Some might even live in what Hillman (2016) terms “education deserts”. They lack any reasonable commutable choices for post-secondary education. 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. Conversely, family and work commitments can often pull rural students away from their college studies (Hlinka, Mobelini, & Giltner, 2015). Rural students might also lack high-speed internet, which can limit their use of online learning opportunities. (Salemink, Strijker & Bosworth, 2017).

Overall, the best support that instructors can provide for rural students, regardless of education level, is to foster a personal connection and relationship with these students (Bers &

Schuetz, 2014). These personal relationships can help students remain in school and complete their degrees. Schinske and colleagues' taskforce (2017) promoted biology-specific education research at the community college level as:

an exciting area for exploration with enormous potential to uncover unique perspectives on biology education and foster innovations that could enhance community college student success and assist in diversifying STEM programs (Schinske et al., 2017, p10).

Improving student success is also important for rural communities' survival. In their small communities, which can have difficulty recruiting qualified STEM employees such as nurses, these students represent a local labor force that can add much economic value (Dowd, 2007).

Promoting post-secondary education of rural students brings about unique challenges 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 low socioeconomic status (Hillman, 2016; Byun, et al., 2012; Dowd, 2007; Hlinka et al., 2015). In contrast, I propose based on previous research that educators change their view that rural students are deficient. Instead, I recommend they capitalize on the strengths of these students by emulating the practices and beliefs of experienced rural community college biology instructors (Hlinka et al., 2015). In this article, I present four research-based principles to help instructors support rural students in post-secondary biology classrooms. I have named them the CARE principles.

DERIVATION OF THE CARE PRINCIPLES

Rural community college educators stand at the forefront of science education for these students and are an important source for best practices. Rarely are community college instructors' practices and beliefs studied except through broad survey methods. This fails to capture some important details. Thus, in our previous studies, I looked in depth at three instructors' beliefs and practices when teaching biology to rural community college students in the Midwest through case study methodology (Birt, Chapter 2, 2018).

Table 4.2: College and Participant Instructors' Characteristics Summarized

	Meg	Jane	Richard
School Name (pseudonym)	Northbend	Southview	Eastside
Type of Campus	Satellite	Satellite	Main
College enrollment	180	600	2,300
Town size (population)	12,000	19,000	11,000
Nearest Metropolitan area	1 hour	1 hour	40 minutes
Years Teaching	15	12	26
Diversity	80% white	93% white	93% white
Course Observed	Introductory Plant Biology	Microbiology for Allied Health	Microbiology for Allied Health
Number of Students in course	9	10	19

Over the course of a single semester, I followed these three experienced biology instructors (profiled in more detail in Table 4.2) into their science classrooms on several occasions to observe their practices. Through semi-structured interviews, I documented their beliefs about teaching and learning. I took detailed notes of the instructional strategies they had planned, as well as the strategies I observed. The instructors—Meg, Jane and Richard (pseudonyms)—had combined experience of over 50 years teaching biological science to rural students. Finally, by comparing and contrasting the instructors' beliefs and practices, I

established that in the context of the three courses and instructors studied, the rural instructors used more student-centered instructional practices (Birt, Chapter 2, 2018). These student-centered instructional practices aligned with recent reform documents such as those published from the AAAS and NRC (AAAS, 2011; NRC, 2003). I drew on the results of the previous studies, as well as additional interviews with students from each course observed. The student interview data provided the students’ perspective of the instructors’ actions and informed the derived principles. I have drawn on the education literature and our conclusions from this study to propose four principles for post-secondary educators to consider when teaching rural students in their biological science courses.

CARE PRINCIPLES EXPLAINED

Overall, these four principles from the case study can be summarized with the acronym “CARE”. Table 4.3 provides a definition of each principle. The principles emphasize the fact that community college instructors establish a relationship with each student to help support him or her through the college science education journey. For each of the four principles below, I provide an explanation of the principle, a brief review of the literature supporting this principle and examples from the case study to illustrate the principle.

Table 4.3: 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 adaptable in instruction to meet students’ needs each semester.
R	Remain respectful of students’ outside commitments and needs.
E	Design expansive learning experiences which challenge rural students to encounter viewpoints and stances different from their own.

*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 (Latz & Rediger, 2015; Bers & Schuetz, 2014). Within the class content, biology lends itself to connecting content with students’ lives. When the content is seen as important and understandable to students, students are more engaged (Hadre 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 (Zielinski, 2017).

The 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 local measles outbreak that had made headlines that very semester. Within the first 20 minutes of one lecture I 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. They noted that the stories helped them to remember the content on exams.

Another instructor, 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 list all the requirements of a cell using the laboratory-cultured cells as an example. Working together, her students came up with a more detailed list of cell metabolism requirements.

Finally, Meg taught a non-majors plant biology course. She realized many of her students lived on farms, so she often incorporated agricultural examples into her lectures to illustrate course content. Meg also knew not all of her students were farmers, which led her to choose other examples widely familiar to all students. These included the ripening of bananas from a grocery store, human development and 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 non-majors courses can get very techy, especially with terms, so you can lose students very easily”. Meg carefully incorporated these examples into her lectures so students could clearly understand the underlying concepts. This process requires a bit of trial and error. For example, during one observation, Meg described the U.S. military’s use of Agent Orange during the Vietnam War to illustrate content about plant hormones. She found this example did not capture the interest of the students. Upon reflection, she noted this example probably was not contemporary enough to fit the content needs of the course. Meg noted she was hopeful she would find another illustration to use the next time she taught plant hormones.

Outside of the classroom, the rural community college instructors made an effort 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 **adaptable** in instruction to meet students’ needs each semester.*

The literature also supports the principle that instructors who are adaptable to modifying their instruction to meet students’ needs are more successful instructors for students (Windshitl, Thompson, Braaten, & Stroupe, 2012). 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, 2006). Yet more recent studies point to an increase in student-centered practices (Zielinski, 2017). Previous comparison studies of community college instruction have found that student-centered instruction, rather than teacher-centered lecturing, might not have improved student content outcomes, though fewer students dropped the science course (Lynse & Miller, 2017). Additionally, the instructors were more satisfied with their teaching using student-centered methods (Lysne & Miller, 2015).

I found Meg and Jane, located in comparatively rural contexts, practiced student-centered instruction. 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 continued to adapt her course almost daily to meet students’ needs. In the semester of study, Jane noted that her students successfully performed group

work. They shared responsibilities and knew one another's strengths. Because of this, she assigned and designed more group work activities. Jane also 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. She rationalized this, "Because they weren't doing it, so it wasn't helping them." Jane believed if the students did not enjoy or participate in the learning activity, then it was highly unlikely they would learn the concepts. Jane showed this adaptability not only in instructional activities but also in her content goals for lessons. 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. Therefore, Jane kept her content goals for the day adaptable when preparing for class as well as during her class time.

Meg showed her care for her plant biology students in her adaptability by completely changing her instructional style mid-semester. She decided to do this because she found that her current group of students was not engaged during her usual lecturing. Instead of lecturing, Meg chose to have 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 hands-on activities helped them learn and kept their interest. Meg described her reasoning behind this adaptation to her course as, "so I think that sometimes, when you have the more mechanical students, if you give them something to do, they are more engaged with it". She also added a more practical component to her exams. For one exam, she had students classifying types of leaves in class as part of the written exam. Overall, the rural instructors took the students' backgrounds and strengths into consideration

when planning instructional activities to keep their students engaged and motivated in their classrooms.

*R – Remain **respectful** of students’ outside commitments and needs.*

Next, science instructors of rural students can show they care for their students by being respectful of students’ outside commitments. As with many students, rural community college students have other demands on their time besides school. It is important for instructors to remember that more than 79% of community college students are employed at least part-time (NCES, 2017). As described previously, students can have family obligations such as children, spouses or other extended family demands (Bers & Schuetz, 2014; Hlinka et al., 2015). Although these strong family ties can be a motivator to continue in college, they can also inhibit the completion of students’ education when family obligations overtake school time (Hlinka et al., 2015). Many instructors overlook the fact that while students might have access to college enrollment, those who do not complete their degree often attribute their incomplete education to work and family needs (Bers & Schuetz, 2014). Instructors can help students navigate these demands on their time in many ways.

In all of the student interviews, the students listed three main constraints on their time: commuting, work schedules and family commitments. Jane provided many examples of respectful interactions with students in her course planning. First, Jane described how, at the beginning of each semester, she polls students to ask how far they commute to campus. That way, she knows how much warning time she needs to give students if she is going to cancel class for the day in cases of sickness or bad weather. She explained that after learning students’ commute times, which can be up to two hours one way, she can plan accordingly. She said,

“and that colors things, like how hard I try to find someone to watch my sick kid for an hour.”

Secondly, as I mentioned earlier, Jane chose to treat activities in an adaptable way. If she found that students were not taking time to do course readings or homework, she would stop assigning them. She also had an unusual grading policy. If students did not turn in an assignment, Jane did not penalize them with a zero. Instead, she reduced their total number of available points for the class.

Meg noted the importance of respectful understanding. One student in her plant biology course worked overnight before coming to class. Meg described noticing that the student would frequently fall asleep in class. Rather than call attention to her, Meg instead began to add more active, hands-on laboratory projects to help this student stay engaged with the content. Meg was aware of the demands on students' time when assigning homework. She carefully curated out-of-class assignments so that each had a clear purpose for learning to avoid assigning busy work. She did not want to waste students' time on activities that did not directly meet the course learning objectives.

Richard also showed respect for his students' other commitments. He began to adapt his out-of-classroom 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 in previous courses. This allowed students more time to work on their research paper. He also added a template for the microorganism list that had all of the required categories listed and formatted. Students just needed to fill in the required information, saving them time and helping them succeed. He also shortened the research paper, in which students investigated a single disease-causing microorganism. Overall, the rural instructors in this study

directly told their students they were concerned with time conflicts, and they shared their reasoning for learning activities outside the classroom.

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

The final principle is unique in that, at first glance, it directly contradicts the principle of connecting to students' personal lives. Nevertheless, rather than causing a disconnect, designing expansive learning opportunities provides rural students with 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, Carrington, & Adie, 2015). Although this makes students more comfortable, it can also lead to disadvantages for rural students. This is because there are fewer chances for students to grapple with viewpoints that challenge their own world view (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 students to explore the world outside of their own community. She described an incident in her microbiology course that prompted her to add a global component to all her courses.

I was teaching microbiology, and I showed a picture of the slums in India, and we were talking about rabies. 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."

First, 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, Meg also took the students' backgrounds into consideration. 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 experiences to expand her students' understanding of the world around them.

Although the other two instructors did not actively plan to include global learning opportunities, they did include some instances of teaching about global issues. For example, Jane talked about the loss of bee populations around the world, and Richard discussed vaccinations people must receive to visit Brazil because of diseases unique to the geographical area. Community college science instructors stand at an important place in rural students' lives, which can help them see their place and the effects of their actions on the larger world (Epply, 2017).

Table 4.4: Alignment of CARE Principles with examples from Rural Biology Instructors

	Principle	Examples:
C	Connective	Richard – Connected the 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) – Alpha Kappa Rho Honor society mentor to students; Discussed and took interest in students’ lives before and after class.
A	Adaptable	Jane – Adapted course activities regularly to meet students’ content needs; Used class time to review difficult concepts students struggled with
		Meg – Changed her instructional style to include less lecture and more hands-on activities to keep students’ engaged; Adapted exams to include a more practical component
R	Respectful	Jane - Did not take off points for incomplete assignments but rather decreased the total points available for that individual student; Was aware of student commute times when considering class cancelation policies
		Meg – Tired students were not penalized for sleeping in class but Meg adapted the activities to be more active to allow for more engagement; Carefully considered the connection of each assignment to learning objectives to eliminate busy work; 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.
E	Expansive	Meg – Designed course activities which had students examine global use of plants Allowed for anonymous student questioning when teaching difficult content such as evolution
		Jane – Included discussion of global problems connected to content such as the loss of bees
		Richard – Discussed vaccines needed for diseases more prevalent in countries outside the US.

CONCLUSIONS

Rural community college biology instruction is often overlooked in the education literature base. But it represents an important untapped source of innovation and improvement in college science teaching principles (Schinske et al., 2017). The CARE principles described here provide a starting point for college instructors working with rural students. They remind instructors to be aware of students' backgrounds, to engage students in the content, to respect students' commitments and to design expansive learning experiences. These principles draw on the strengths of rural students, such as their commitments to family and their community, rather than treating their perspective as a disadvantage.

I recommend that future studies into instructor practices be undertaken at additional rural community colleges to further refine the CARE principles. I also suggest that studies of rural students be conducted after they transfer to four-year universities. This is important because it will help researchers examine the level of support students receive during an often-difficult transition. Although these principles are supported by examples from small Midwestern rural community colleges, I put forth that many of these principles are applicable across a wide variety of contexts, including those with different geographical and cultural contexts. Biddle and Azano (2016) asserted that more interest needs to be shown in training teachers to teach in rural contexts rather than in urban contexts only. I agree that more professional development should be done. Specifically, it should be aimed at helping rural college instructors draw on a frequent strength of rural students—persistence—to help students complete their degrees.

Finally, it is imperative to support rural students in biological sciences as they work to complete their two-year degrees or certifications. This post-secondary education stands to strengthen not only students' lives but also rural communities (Dowd, 2007). A solid background in science will help rural students improve their scientific literacy and navigate the current political environment in which many people often place little value on scientific evidence for decision-making.

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CHAPTER 5

CONCLUSIONS

In this dissertation, I have explored community college instructors' beliefs and practices when teaching biological sciences to rural students. Post-secondary education of rural students is an important topic for today's research in education. Previous studies have focused specifically on urban schools, but recently researchers also have begun to examine rural students' education. Katsinas and Hardy (2012) agreed that researchers' attention should be shifted because rural community colleges represent 50% of all community colleges and educate 30% of college students. In the concluding chapter of this dissertation, I summarize each of the three manuscripts and review the overall findings with further questions this research has sparked for future studies.

In Chapter Two, I examined the beliefs and practices of three rural community college biology instructors with a multiple-case study approach. Cross-case results indicated that overall, the rural instructors considered students' future careers, acted as explainers of the content using real-life examples, and valued group work for learning. Some of the instructors did this by using student-centered instructional strategies. These results are unique in that previous studies found that community college instructors used more teacher-centered practices (Mesa, Celis & Lande, 2014). Through the lens of the curriculum development model, which uses personal practical theories to describe teachers' beliefs, I found that the instructors held beliefs that were consistently manifested in their practice. I also noted that not all of the instructors completed the curriculum development cycle. For example, Richard failed to reflect on the effectiveness of his instructional practices, which in turn did not lead to any changes in

practice or beliefs. The curriculum development model provided an important framework for studies of instructor beliefs when considering the course context. I concluded that these rural instructors stand at an important place in rural students' post-secondary college careers. The instructors' use of more student-centered strategies and careful consideration of student motivation can be emulated by others hoping to foster rural student success.

Chapter Three focused on the same three instructors' practices and beliefs, specifically their assessments. Through a multiple case study approach, I qualitatively examined the three instructors' personal practical assessment theories and assessment practices. Using the assessment development model, I found that the instructors held varied beliefs about the focus and adaptability of the assessments used. The results from this study suggest that two of the instructors were highly adaptable within their course planning, basing assessments on student needs and interests. Meanwhile, one instructor rarely adapted his assessments other than to prevent instances of plagiarism. With regard to focus, two of the instructors designed their assessments to evaluate students' content knowledge, while the other was interested in using assessments to help students learn and grow in their critical thinking, speaking and writing skills. These findings are significant in that they show that more experienced instructors tend to be less adaptable in modifying their assessment practices. It also illustrated the importance of the reflection portion of the assessment development cycle. Instructors who spent time considering the results of their assessments were more likely to adapt them as needed.

Chapter Four provided practical implications for instructors of rural students. This chapter introduced four principles derived from the results collected in chapters Two and Three. I presented four "CARE" principles supported by previous research in rural and

community college education. In summary, the CARE principles prompted instructors to consider: connections to students' daily lives in and out of the classroom, adaptability in instruction, respectfulness of students' extracurricular commitments and design of expansive learning opportunities. I see these principles as a practical contribution which provide advice for instructors of rural students across all levels of post-secondary instruction. They support the idea that if instructors can foster personal connections with their students, student success can improve (Bers & Schuetz, 2014). I closed the chapter by showing how each of the three instructors illustrated the CARE principles. These principles are important because they support rural students, who can grow into influential leaders responsible for building the small communities where they live, work and study (Dowd, 2007).

There are a number of considerations that emerge from this research. First, education researchers and instructors need to reevaluate their views of rural, post-secondary instruction from a deficit model to a strengths model (Hlinka, Mobelini & Giltner, 2015). Although rural students might have some disadvantages in socioeconomic status, their backgrounds provide many strengths. The instructors in this study recognized and adjusted their instruction accordingly. For example, Meg understood that many of her students had agricultural backgrounds, so she included agricultural examples when teaching plant biology. In another example, Richard did not lower his course expectations but held his students to higher standards based on his previous experiences as a rural community college student. He challenged his students to push themselves to work hard to meet his expectations rather than making excuses for them. Thus, I believe it is important for us to reframe the conversation around rural education to draw on students' and instructors' strengths.

Second, aligned with the previous point, experienced rural community college instructors can provide exemplary examples for other instructors trying to teach and make connections with rural students. Schinske et al. (2017) led a biology education task force that concluded research about community college instructors—specifically, their focus on teaching and student advising—could provide insights not seen at larger universities. This observation held true in this dissertation. For example, the results described in Chapter Three showed Meg and Jane’s adaptability in instruction when considering students’ interests and understanding. As noted in Chapter Two, wide-sweeping changes can also take place. For example, Meg completely changed her instructional strategies to include almost exclusively in-class activities rather than instructor lecturing. She made this change because she noted her students were more engaged with hands-on activities.

Third, professional developers should carefully consider allowing and prompting instructors to consider reflective activities, which require them think about the results of their instructional practices and assessments. The empirical studies included in this dissertation found instances in which instructors failed to complete the reflective portion of their curriculum development models. This led the instructors to continue to use practices that did not result in student gains in content knowledge or skill improvement. Thus, the instructors might have used practices that were not helpful to students. When instructors did engage in reflective practices, they often adapted and changed their future instruction to better serve their students. In a similar manner, professional developers should prompt instructors to consider their views of rural students. When prompted, instructors in this study held varying views of rural students. Some expected them to be like any other college students, while others carefully considered

their motivations and needs when designing instruction. Metacognitive activities that allow instructors to examine their motivations might also help to effect change when considering reform efforts.

This study, as with all scientific studies, prompts more questions than it resolves. Future research should delve into differences in instructors' beliefs and practices in various rural contexts. It is also important to consider more direct comparison studies between urban and rural instructors. These should use detailed methods such as case studies, which consider the context of instruction, rather than the usual survey methods. Any research that leads to further information on how to improve rural student success is an important study to pursue in today's political environment. It is my hope that my future research in rural education will help to improve the outcomes of rural students as they pursue their goals of post-secondary education and careers. Rural students represent an important group of future leaders who can contribute much to universities' goals of fostering more political and economic diversity on campuses.

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VITA

Julie spent her formative years raising chickens, ducks, dogs, Oxford sheep and all manner of farm creatures in rural Missouri which fostered for her a love of animals and science. She served in many leadership roles as a member of 4-H. After graduating with Viking honors from Francis Howell High School, she completed a bachelor's in animal science from the University of Missouri, becoming the first person in her family to graduate from college. A series of jobs in college led Julie to pursue a career in research. She also met her husband, Nate, a wayward journalist who continues to need reminders about the value of the scientific method compared to anecdotal evidence and hearsay. Under the direction of Dr. Kathy Timms, she completed her master's in animal science with an emphasis in reproductive biology and molecular biology. After a brief time in St. Louis, she and her husband moved back to Mid-Missouri. In her free time, she started teaching again online and decided to pursue her Ph.D. in Science Education with Marcelle Siegel so she could follow her passion for teaching. Today, she helps university faculty fortify their writing-intensive courses while parenting three sons and a daughter, who have their own chickens. In her free time, she enjoys gardening, reading books and exploring nature with her children.