-Exploring ATCP Science Teachers’ Inquiry-Based and Learner-Centered Practices

through the Lens of Teacher, Program, and School Context Configurations

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A candidate for the degree of

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And hereby certify that, in their opinion, it is worthy of acceptance.

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DEDICATION

Thanks to my children: Michael, Emma, Danny, and Nate, to whom I dedicate this dissertation, for their numerous sacrifices so I could work full-time, attend classes, study, finish homework, participate in internships and practicum, perform research, analyze data, write a dissertation, and try to find time to be a mom.

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ABSTRACT

This study focused on the inquiry-based and learner-centered instructional practices of alternatively certified science teachers through the exploration of configurations of teacher, program, and school contextual characteristics that are believed to contribute to instructional decisions. Inquiry-based and learner-centered continuums were used to look at the level of teachers’ instructional practices. Growth trends in inquiry-based and learner-centered practices were created, displayed, and discussed. Cluster analysis was used to determine how, if at all, teachers’ group by teacher, program, and school context characteristics. All of these were used to summarize alternatively certified teachers’ use of inquiry-based and learner-centered instructional practices seeking possible configurations associated with levels of outcomes. My study found that there were clusters of teachers present whose practices were associated with several different configurations consisting of the presence or absence of teacher, program, and school context characteristics.
CHAPTER 1

Before I came to the University of Missouri (MU), I taught science grades 1 through 8 at a charter school in Colorado Springs, Colorado. I had neither a teaching certificate nor a degree in education; but I had a love of things scientific and a passion to motivate students to see the wonders of the world around them, to understand that world, and be able to explain its processes. I wanted them to be able to discern credible sources of information and to understand that the processes of science were not necessarily the much-taught and rigid scientific steps. I wanted them to be aware of those steps, but not to see them as written in stone, but more as a scaffold of an iterative process. I wanted them to think about questions they had about the world around them, about biotic and abiotic processes, and I wanted them to feel the excitement of discovery and inquiry. I didn’t know the vocabulary of inquiry and discovery, their rationales, or underlying philosophies. I simply knew that I had always loved science, but hated my science classes and I didn’t want that for the kids I was teaching; instead I strove to learn how to harness their natural human curiosity.

Unfortunately, many of the students in my class had experienced surface learning (Marton & Saljo, 1976) of science as a set of teacher disseminated discreet facts and vocabulary that needed to be memorized, yet were totally irrelevant to and disconnected from my students’ personal lives. I believed that many children were receiving science instruction in ways that not only turned them off to science, but also left most of them ignorant of how science is practiced and unprepared to digest information on scientific issues (Association for Supervision and Curriculum Development, 2012). As Ramsden
(1988) said in speaking about traditional science teaching, “Texts were a flat landscape of facts to be remembered, rather than an area dotted with salient features representing principles or arguments around which stretched plains of evidence” (p. 23). As Nelson (1999) also pointed out, “over the last 50 years, K-12 science, mathematics, and technology curriculums have become ever-expanding accumulations of facts, vocabulary, and hollow activities” (p. 15). Abell (interview, 2004) also noted, “We’ve got a problem in terms of the quality of the teaching and the quality of the outcomes – student achievement…”

This concerned me because I believed:

• Science can enhance one’s enjoyment of life in general while providing insight into problems and perplexities encountered in life;

• Science is important to understand the world around us so we can actively participate in local, state, and national concerns, policies, and legislation on issues falling within the realm of science (e.g., global warming, recycling, forms of energy, advances in technology and medicine, etc.);

• Cutting edge science is important for national security and economic success, and children’s experiences in science may lead them away from seeking careers in science thus depriving our nation of their possible future contributions; and

• Learning science can be an exciting and enjoyable experience for students while simultaneously opening a world of exploration, discovery, and meaningful learning through knowledge of scientific history, facts and concept building through facilitation and guidance in scientific ways of thinking and processes.
As I thought about children enjoying science, I was also aware that aggregated scientific knowledge within a nation impacts every dimension of a society from the basic survival of individuals and nations to an elevated quality of living on both individual and national scales (Nelson, 1999). Science has provided breakthroughs in major areas of life impacting health and medicine, man-made products that enhance and improve life, agricultural and environmental processes, harnessing of natural processes; communication systems, modes of travel, military weapons, and entire economies, etc.

In 1999, writing on scientific literacy Nelson noted,

> As the world becomes increasingly scientific and technological, our future grows more dependent on how wisely humans use science and technology. And that, in turn, depends on the effectiveness of the education we receive. With the exploding impact of science and technology on every aspect of our lives, especially on personal and political decisions that sustain our economy and democracy, we cannot afford an illiterate society (p. 14).

In 1996, the American Association for the Advancement of Science (AAAS), the National Academy of Sciences, and the National Science teachers Association (NSTA) issued a joint statement supporting basic universal science literacy for all students consisting of an opportunity to access scientific knowledge and develop scientific habits of mind, and an understanding of the nature of science, its connections to math and technology, as well as its impact on individuals and its role in society. They and others (i.e., Ramsden, 1988; Weimer, 2002, etc) have warned that the amount of material in
today’s science curriculum needs to be significantly reduced to deepen students’ understandings and provide needed time for students to be actively involved in exploring nature in ways that resemble how scientists work (Nelson, 1999, p. 15,16).

Scientific literacy is a major key to our nation’s progress as a world power. As such, science is deemed a crucial element in the education of our nation’s children. However, as discussed above, over the last 20 years, concern has been voiced about the level of scientific literacy of America’s populace and decreasing interest among American students to choose science-based career fields (Ozborne et al, 2003), which has been traced to what and how children are taught science during their Pk-12 education (Hanushek & Lastra-Anandón, 2011). Further, Hanushek (2011) reported that within the next few years America will suffer a serious gap of about 2 million workers prepared with the necessary analytical and technical skills to take their place in the US workforce (p. 51).

President Obama expressed concern in his 2011 State of the Union Address, “We know what it takes to compete for the jobs and industries of our time. We need to out-innovate, out-educate, and out-build the rest of the world.” In light of this, Hanushek’s (2011) concern is especially relevant: “the challenge is particularly great in math, science, and engineering” (p. 51). Entrepreneurs such as Vinton Cerf (2011) lament, “America simply is not producing enough of our own innovators, and the cause is twofold—a deteriorating K–12 education system and a national culture that does not emphasize the importance of education and the value of engineering and science” (NP).

Yet science is more than a vehicle to global dominance. Scientific practices are a powerful way for children to learn how to process information and to think about the
world in general. Science provides scaffolding to learn how to think critically, to learn how to evaluate information and sources of information. It adds enjoyment to life through understanding and knowledge of the intricacies and complexities of life on Earth and throughout the universe. Science instruction can also fuel children’s natural curiosity and supply them with answers to the myriad of questions and seeming mysteries and inconsistencies that surround their lives. The National Research Council (2000) wrote, “teachers can help all their students understand science as a human endeavor, acquire the scientific knowledge and thinking skills important in everyday life and, if their students so choose in pursuing a scientific career” (p. 6).

Science well taught can propel children’s natural interests in the world around them to careers in science, which our nation needs if it is to stay competitive in our global economy. But how to keep children interested in science as they progress through school has proven difficult. The teaching techniques that once sufficed no longer provide the quantity and quality of scientific literacy now needed. So, how do we raise the level of scientific literacy in our nation? Many believe it begins with school and how children are taught. Along this line, Weimer (2002) mused, “I came to accept that one of my tasks as a teacher was developing lifelong learning skills and the confidence to use them” (p.5). She then asked, “What kind of teaching, assignments, and classroom environment would accomplish that? How would those kinds of learning experiences be evaluated” (p.5)?

**Inquiry-Based Science Education.** The traditional science classroom with its “cookbook” labs has proven insufficient to motivate student interest in science or to attract enough students to careers in science, thus depriving them of the opportunity to experience science in its fullness while depriving our nation of their future intellectual
scientific contributions. Nelson (1999) argued that traditional instructional practices, with their emphasis on learning answers more than exploring questions, memorization of bits and pieces of information in place of understandings within a context without critical thought or argumentation; and over-reliance on reading instead of hands-on experiences work against a vision of scientific literacy. He further remonstrated that traditional instructional practices lack the collaborative nature of group work and often fail to use technology to sharpen and extend student’s intellectual capabilities. He explained,

In learning science, students need time for exploring, making observations, taking wrong turns, testing ideas, and doing things over, time for building things, calibrating instruments, collecting things, and constructing physical and mathematical models for testing ideas; time for learning whatever mathematics, technology, and science they need to deal with the questions at hand; time for asking around, reading, and arguing; time for wrestling with unfamiliar and counterintuitive ideas and for coming to see the advantage in thinking differently (p. 16).

Nelson (1999), Weimer (2002), the National Science Foundation, and the National Science Teachers Association, among others, propose inquiry-based classroom instruction to provide the learning opportunities lacking in traditional science instruction. Inquiry places an emphasis on what we know, why we know, and how we have come to know (National Research Council, 2000) and utilizes methods built upon a constructivist approach to science instruction allowing students to become actively involved in authentic scientific practices, which when appropriately and effectively used are viable
alternatives to traditional teaching methods. Over time, inquiry increases retention of knowledge; generalizability of learned content to other situations, coursework, etc; students’ interest in science, and metacognition (Kuhn et al, 2000; Metz, 2004; White & Frederiksen, 1998).

The National Research Council (1996) defines inquiry as a “set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories” (p. 214). Inquiry is learner-centered and focuses on deeper conceptual understanding, while traditional methods of teaching science are more teacher-centered and focus on the transmission of information and skills from teacher to learner (Khan, 2009; National Research Council, 1996, 2000). Khan (2009) states, “inquiry engages students in active learning by giving them the opportunity to think about the world around them” (p. 44) and prompts students to ask questions for which they must seek answers, rather than to validate questions and answers already known (Smith & Hall, 1902; National Research Council, 1996). Smith and Hall (1902) felt that inquiry kept the pupil “just enough in the dark as to the probable outcome of his experiment, just enough in the attitude of discovery, to leave him unprejudiced in his observations” (p. 278). Finally, the National Research Council (2000) finds that the value of inquiry lies in its ability to exploit students’ natural curiosity. However, the National Aeronautics and Space Administration (NASA) cautions that

Many activities used to teach science are mindless “hands on” lessons and do not engage a “minds on” response. Capable students can see the activity outcomes without going through the procedures and are not
challenged. Many educators think inquiry learning takes place only through student activities. Teacher demonstrations, classroom discussions, and even lectures can encourage the development of the essential elements of inquiry if the focus is on “how we come about knowing” rather than on “this is what we know (p. 3).

**Inquiry-Based Teaching and Teacher Development.** Generally speaking, inquiry is considered a complex and difficult way of teaching science. Research shows that there has always been confusion over the use of inquiry in science teaching and how it can be effectively promoted in a real classroom context (Wee, Shepardson, Fast & Harbor, 2007). Inquiry requires practice and time to reach expert levels. Khan (2009) reported several instructional challenges in utilizing inquiry in the classroom: the teaching of abstract ideas; curriculum coverage; diversity of students; time, resources, and classroom management; and motivation of students toward inquiry teaching. Khan (2009) also found another difficulty – the level and use of mathematical concepts needed for calculations, interpretations, justifications of findings and their alignment to students’ skills, abilities, and previous experiences in mathematics.

Bybee (2000) argues that understanding what inquiry is, is not enough – teachers need to be able to design and implement lessons using inquiry, which requires, according to Lawson (1995) three essentials: “(1) a thorough understanding of the nature of scientific inquiry, (2) deep understanding of the structure of the discipline, and (3) skill in inquiry teaching techniques” (p. 22). This is far easier said than accomplished, and
Llewellyn (2005) on inquiry advised that inquiry-based practices require years of “sustained perseverance and reflection” in the development of expertise (p. 51).

Though research supports the use of inquiry-based practices a sobering picture emerges – given the current teacher education system few teachers will attain expertise in inquiry-based instructional practices or any other teaching practices as they enter their first year of teaching. We can, however, expect that given opportunities to teach and observe teaching during teacher education, that teachers could enter teaching with entry level knowledge of and skills in inquiry-based practices. We can also expect that teachers could develop and move toward expertise in inquiry-based practices over time as they continue to teach.

Opportunities to learn about, observe, and experience inquiry-based practices while still a student is a function of the program within which a teacher learns how to teach. Moreover, the opportunity to develop inquiry-based practices is also a function of the school environment within which a teacher teaches. Finally, how much a teacher is capable of learning about constructivist approaches and inquiry-based and learner-centered practices is contingent upon past experiences that can either impede or facilitate teachers’ growth. Importantly, research has consistently supported that teacher performance improves with experience (Wiswall, 2011).

Teachers’ understanding of inquiry is also furthered by teacher educator modeling of inquiry and instructor transparency. By transparency I mean that instructors not only model inquiry, but make inquiry explicit through questioning processes, such as: What did I just do? Why do you think I did it that way? How could you use this in your
classroom? Weimer (2002) addresses the difficulty with which college faculty often have in modeling inquiry and student-centeredness:

Daily events in most classrooms feature faculty. We deliver the content, lead (often controlling and directing) the discussions, preview the material and then summarize it, and provide the examples and ask students the questions about them. We are there solving the problems, providing the diagrams, graphs, and matrices. We work diligently to lay before the students the disciplinary landscape of our fields. When it comes to who is working the hardest most days in class, we win hands down (p. 73).

Good teaching matters particularly for disadvantaged students. Hanushek (1992) and others’ (e.g., Rivers & Sanders, 2005; United States Department of Education, 2000, Walberg, 2005, etc.) found that besides students’ home environment, school environments are the most influential and alterable influence in student academic success. Additionally, Hanushek (2004) later concluded, “...a good teacher will get a gain of one and a half grade-level equivalents, whereas a bad teacher will get a gain of only half a year for a single academic year” (p. 3) and that high quality teachers over a period of at least three years can alleviate the typical preparation deficits of students from impoverished and/or disadvantaged backgrounds. Fredrick and Hummel (2004) further found, “The difference between attending school and receiving an excellent education lies in the instruction students receive while in school” (p. 9). As well, Goldhaber (2006) stated, “The effect of increases in teacher quality swamps the impact of any other educational investment, such as reductions in class size” (p. 4). Finally, Lazarowitz and
Tamir (1994) consider teachers the most important variable in student success and achievement. So, it is teachers and the instructional methods they use to create learning environments for students that make a difference in positive student outcomes. As McKinsey and Company (2007) succinctly stated, “The quality of an education system cannot exceed the quality of its teachers” (p. 17).

**Alternative Teacher Certification**

In light of the preceding, it is easy to understand how the idea of alternative routes to entering the science classroom as the teacher of record can be an issue of concern. Most alternative routes include the opportunity to enter teaching within a much shortened time-span as compared to the more traditional 4-5 years to licensure. Considering the amount of time necessary to expertly use inquiry-based methods or to merely enter the classroom prepared to use entry-level inquiry-based practices and to experience growth in those practices raises concern that teachers prepared through alternative routes may not be able to use inquiry-based practices appropriately or effectively.

Proponents of the traditional teacher education program consisting of 4-5 years of study in content and education foundations do not believe that alternative certification programs can supply the amount of instruction and practice time for teachers to enter the classroom adequately prepared. In contrast, proponents of alternative teacher certification believe that life’s experiences, which include past education and career experiences, are sufficient to enter the classroom prepared to teach and grow in the necessary skills with appropriate mentoring and professional development. To date, extant research on the superiority of one method of preparing teachers over the other has been inconclusive.
Given the role of teachers in student outcomes, the need for teachers to use the most powerful teaching methods is paramount. Inquiry-based practices and a learner-centered orientation are powerful instructional tools. As such, it is important to know whether or not teachers graduating from alternative teacher certification programs use inquiry-based practices and possess a learner-centered orientation, at what level they begin using inquiry-based practices and whether or not they grow in those practices, and which factors or configurations of factors related to programs, school contexts, and teacher characteristics are involved in teachers’ use of inquiry-based practices and the development of a learner-centered orientation. Allowing inexperienced science teachers to enter a classroom through an alternative certification route (ACR) as the teacher of record is an issue of concern.

Hence, this study focuses on alternatively certified teachers (ACTs), their characteristics, their instructional practices over time, the context of the schools in which they teach, and the programs from which they graduated. To best understand and delineate what teachers are doing in the classroom as suggested by Cochran-Smith and Zeichner (2005), this study looks at longitudinal research following ACTs in their programs and through their first years in teaching.
Significance of the Study

The significance of this study is found in teachers’ influence on student outcomes. Teachers are considered the most important and alterable variable in student outcomes outside of family contexts. Student outcomes affect the welfare of the nation through students’ ability to take their place in US society as fully functioning adults and through their ability and choice to pursue careers within the science fields (Kozol, 2005; Ingersol & Perda, 2010; Lochner, 20040). Because alternative teacher certification programs (ATCPs) produce 20% of the teaching force nationwide (Feistritzer & Harr, 2008), and because inquiry-based practices combined with a learner-centered orientation are considered one of the most powerful ways for students to become scientifically literate, it is important to know whether or not alternatively certified science teachers use inquiry-based practices to teach science as they enter teaching and whether or not they experience any growth in their practices over time.

Rationale and Purpose of the Study

Alternative teacher certification has become an established route to teaching in the 21st century; however questions remain concerning ATCP outcomes, especially the ability to produce quality teachers who can effectively utilize inquiry-based science instructional practices. More research on ATCP outcomes is necessary to understand their efficacy through the abilities of their graduates. The purpose of this study is to document the outcomes of ATCPs in the state of Missouri, specifically looking at: the instructional methods used by the study’s participating teachers; the teachers’ past work experiences; the school contexts within which the teachers worked; and factors within the teachers’
ATCPs. More specifically this study analyzes, compares, and contrasts alternatively certified science teachers’ inquiry-based instructional practices looking for connections between their observed instructional methods, their past experiences, their respective ATC programs, and their schools within which they were employed. Through my study, I want to add to the knowledge base on ATCPs and help close research gaps on long-term outcomes of ATCPs by documenting the outcomes of ATCPs in the state of Missouri through secondary data from a longitudinal in-depth study of those programs and the classroom teaching practices of their graduates.

Three research questions focused this study:

1. To what extent do alternatively certified science teachers use inquiry-based instructional practices and exhibit learner-centeredness?
   - How, when, and to what degree do alternatively certified teachers use inquiry-based practices;
   - To what degree and how are alternatively certified teachers learner-centered;
   - How do teachers cluster by their use of inquiry-based and learner-centered practices?

2. How do alternatively certified science teachers’ use of inquiry-based and learner-centered practices change over time?
   - Where do teachers place on an inquiry-based continuum for each year observed;
   - Where do teachers place on a learner-centered continuum for each year observed?
3. To what degree are teacher, program, and school factors associated with alternatively certified teachers’ use of inquiry-based and learner-centered practices?

- How do teachers cluster by factors associated with teachers’ use of inquiry-based and learner-centered practices?

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<tr>
<td>1. To what extent do alternatively certified science teachers use inquiry-based instructional practices and exhibit learner-centeredness?</td>
<td>a. How, when, and to what degree do alternatively certified science teachers use inquiry-based practices?</td>
<td>Create Inquiry-based Continuum on which to place teachers</td>
<td>Using the inquiry-based continuum, place teachers on the continuum and plot coordinates</td>
<td>Combine the two continuums to create a plane with quadrants. Discuss the quadrants on which the teachers lie, in terms of their inquiry-based teaching and student-centeredness</td>
<td>Using all data, create teacher profiles to analyze patterns and and quadrants. Using a representative sample from the inquiry level scale and learner-centered scale clusters to discuss the outcomes of the inquiry-based and learner-centered continuums</td>
<td>Compare and contrast outcomes of all previous steps. Discuss findings. Conclusions Recommendations.</td>
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<td>b. To what degree and how are alternatively certified science teachers learner-centered?</td>
<td>Create Teacher-Centered Continuum on which to place teachers</td>
<td>Using the student-centered continuum, place teachers on the continuum/ Plot coordinates</td>
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<td>c. How do teachers group by their use of inquiry-based practices and learner-centered practices</td>
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<td>Use the teachers’ placement on the continuum to group the teachers</td>
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Definitions

**Authentic Experiences:** to learn about the workings of science, students need to participate in the practices and activities in which professional scientists engage, or an activity appropriate for them, that corresponds closely with these ways of working. This is what is referred to as culturally authentic science learning (In Murphy, Lune, and Jones, 2006).

**Complementarity:** seeking elaboration, enhancement, illustration, and clarification of the results from one method with results from the other method.
**Constructivism:** meaning-making theory that offers an explanation of the nature of knowledge and how human beings learn. It maintains that individuals create or construct their own new understandings or knowledge through the interaction of what they already know and believe and the ideas, events, and activities with which they come in contact (Cannella & Reif, 1994; Richardson, 1997).

**Cookbook labs:** Where children are given the research question, all the necessary steps, and provided with conclusions. In other words, children are validating what was given to them in lecture or through a text book and are not involved thinking about a phenomenon and investigating it.

**Development:** using the results from one method to help inform the other method

**Discovery Learning:** The most fundamental form of inquiry-oriented learning. The focus of discovery learning is not on finding applications for knowledge but, rather, on constructing meaning or knowledge from experiences. Discovery learning employs reflection as the key to understanding. The teacher introduces an experience in such a way as to enhance its relevance or meaning, uses a sequence of questions during or after the experience to guide students to a specific conclusion, and questions students to direct discussion that focuses on a problem or apparent contradiction. Employing inductive reasoning, students construct simple relationships or principles from their guided observations. Discovery learning is most frequently employed at the elementary school level, but at times it is used even at university level.

**Evidenced-based practices:** “Those programs and practices that have demonstrated that they are efficacious through rigorous scientific research” (Gillies, p. 1) to include: experimental, quasi-experimental; design experiments, case studies, and program
evaluation studies. Well done experimental studies provide the strongest evidence. The term evidence–based practices encompasses the 5 standards of science teaching from the National Research Council/National Science Foundation.

**Expansion:** seeking to expand the breadth and range of inquiry by using different methods for different inquiry components

**Inclusion:** “A commitment to creating schools and classrooms in which all children, without regard to individual needs or disabilities, are educated together. Inclusive classrooms embody the belief that diversity is a positive force in children’s and teachers’ lives and should be embraced, rather than ignored or minimized” and “where differences are appreciated” and “become part of the curriculum itself” (Byrnes & Kiger, 2005, p. 37).

**Initiation:** discovering paradoxes and contradictions that lead to a reframing of the research questions

**Innovative Program:** A program for the preparation of professional school personnel that includes all of the elements and requirements of a conventional program, but utilizes non-conventional methods for delivering the prescribed curriculum (ex. field-based instruction, distance learning via telecommunications or Internet, etc.) and may include becoming a teacher of record while still in the program.

Inquiry-based classrooms:

**Metacognition:** self-monitoring, self teaching (Wahlberg in Izumi & Evers, 2005, p. 64). The abilities with which learners reflect upon, evaluate, and monitor their own learning processes (Chatterji, p. 202). The ability to plan, monitor progress toward a goal, reflect on the quality of work, and revise the work or plan accordingly (Eslinger, 2002).
Mixed methods designs: uses qualitative and quantitative data collection procedures or research methods. Mixed methods designs is further divided into mixed method research and mixed model research.

**Purposive Heterogeneity:** a philosophy of full inclusion which recognizes “the value of teaching children to interact comfortably with a wide range of people and so work to create classrooms and practices that acknowledge differences among students among students in the classroom and respond to them thoughtfully and creatively” (Sapon & Shevin, 1999, 2001, 2003 in Byrnes and Kiger, 2005, p. 37), also known as full inclusion.

**Quality Questions:** Goodman and Berntson (2000) described three criteria for identifying quality questions: (a) Accessible, (b) Short, and (c) Leading. The ‘accessibility’ of questions pertains to the students’ ability to make a connection to the question through culture, prior knowledge, or experiences. Quality questions are short, concise, and to the point. Their brevity allows students to instantly appreciate the phenomenon embedded in the question or the knowledge needed to understand the answer to the question. Finally, ‘leading’ is the ability of a question to direct instruction and learning around a specific topic for a prolonged period of time. The question is sufficiently open ended (or the answer to the question is sufficiently complex) that it warrants repeated opportunities for students to think about and examine.

**Standards:** National Research Council Standards outline what students need to know, understand, and be able to do to be scientifically literate at different grade levels and what teachers need to be able to do in the classroom (National Research Council, 1996). Missouri’s standards outline what students need to know and be able to do in all content areas as well as in every grade level and contain four goals: student acquisition of the
knowledge and skills to gather analyze, and apply information and ideas, to communicate effectively within and beyond the classroom, to recognize and solve problems, and to make decisions and act as responsible members of society (Missouri Department of Elementary and Secondary Education, 2010).

**Sustained Reasoning:** a process by which individuals first define and clarify a specific problem and work to find a satisfactory solution over an extended period of time (i.e., days, weeks, or months) rather than a one-time event (NRC, 1999, p. 21)

**Triangulation:** The use of multiple data sources to confirm or corroborate information from other sources (Gillies, 2009)

**Zone of Proximal Development (ZPD):** The range of tasks children cannot yet perform independently but can perform with the help and guidance of others is the zone of Proximal Development (Ormrod, 2006, p. 36).

**CHAPTER 2**
**LITERATURE REVIEW**

My study is concerned with the inquiry-based and learner-centered instructional practices of alternatively certified science teachers in the State of Missouri. This chapter synthesizes the literature delving into inquiry- and learner-centered practices and alternative teacher certification. The variables identified in this literature provided the basis for developing a conceptual framework for the study. As will be explained in Chapter 3, the research design required careful operationalizing of these variables in order to identify them in a complex qualitative database. At the end of the chapter I provide a cognitive map of relationships among the variables and the research questions.
Inquiry-based and Learner-Centered Practices

**Inquiry.** According to the National Research Council (1996), the definition of inquiry depends upon the perspective of the individual engaged in inquiry. When speaking about scientists, inquiry refers to “the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (p. 23). When speaking about teaching science in pre-kindergarten through high school, inquiry also refers to, “the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” (p. 23).

Bybee (2000) further portrayed inquiry as:

- A description of methods and processes that scientists use,
- A set of cognitive abilities that students might develop,
- A constellation of teaching strategies that can facilitate learning about scientific inquiry, and
- A means of developing the abilities of inquiry and understanding of scientific concepts and principles (p. 21)

The last two bulleted items align with the essential features of inquiry (NRC, 2000) which I used in the creation of an inquiry continuum for investigating teachers’ inquiry practices. But how does inquiry look in the classroom, and how do teachers do inquiry?

Wenning (2004) and Khan (2009) among others provide glimpses into how inquiry looks. It begins with questioning. According to the American Association for the
Advancement of Science (1993), the National Research Council (1996, 2000), Elstgeest (2001), Goodman and Bernston (2000), Khan (2009), and Volkman (2012) among others questioning strategies are the driving force in inquiry. Teachers’ ability to ask appropriate quality questions is vital to inquiry, but also important is their ability to adapt questions to their students’ contexts, to ensure that the content they cover with a question is supported by standards, and to adapt questions to learners’ developmental levels. Because of the importance of questioning in the inquiry process, I have included the following section on questioning.

**Inquiry Questioning.** Questioning triggers and encourages students’ critical thinking and pushes them into scientific processes beyond the questions into sustained reasoning (Lustick, 2010). Walsh and Sattes (2005) commented on the purpose of questions, “the purpose of inquiry questioning is to challenge students to think about concepts and to formulate personal responses” (p. 22). To this Lustick (2010) adds the idea of focus questions which, according to Lustick, are “best defined as a query that addresses a natural phenomenon requiring repeated attention by the learner over an extended period of time in order to construct deep understanding of an identified solution” (p. 495). The nature of this type of questioning is beyond memorization, requiring teachers’ careful, thoughtful preparation of the questions presented to students, taking into account the content knowledge and the thinking processes teachers want students to develop through the questioning process. Questioning on this level requires deep understanding of the processes of inquiry, of pedagogical practices, and of content knowledge.
Quality questions should “stimulate curiosity, maintain interest, help students connect content to life experiences, and be complex enough to demand repeated consideration” and “should be tailored to meet the different needs and interests of a specified audience whether an audience of one or 100” (Lustick, 2010, pp. 496 and 497). Teachers can and should emulate the type of questioning used by scientists, but will have to tailor them to fit the time parameters of their courses (Lustick, 2010). “Wilen (1991) reports that while the link between the quality of teachers’ questions and improved student attitudes is inconclusive, he concludes that “students must develop positive attitudes toward higher-level questioning if…inquiry is to be effective” (p. 24). In other words, “if teachers are more equipped to identify, appreciate, and develop meaningful questions, then a classroom culture that places a high value on curiosity may foster greater student engagement in the scientific inquiry” (Lustick, 2010, p. 497).

It is imperative for teachers to identify questions that lend themselves to scientific investigation (Deal and Sterling, 1997). The success of a focal question depends on the skill of the teacher in first identifying the best question for a particular objective (Killoran, 1987). Lustick (2010) provided a guiding framework in the form of a rubric for assessing quality focus questions which covers four areas: (a) content, (b) context, (c) curriculum, and (d) cognition. I used his rubric, Table 3 below, to ascertain the level of teachers’ inquiry questions in rating the first essential feature of inquiry. To use Lustic’s rubric, the first step is to ascertain the presence or absence of one of the dimensions listed on the rubric. Then rate the quality according to the description provided. Overall quality is determined by adding the scores of each dimension of the quality of a question.
Finally, teachers need to look beyond their own feelings and interests and ask questions that are likely to arouse the interest of their students. What a teacher thinks is or should be interesting or motivating to students may not be interesting or motivating at all. Sensitivity to students’ interests as well as knowledge of students’ cognitive levels and experiences are important, especially in supporting areas such as math or reading and writing. Asking questions that go beyond students’ developmental level, prior content experience, and existing context are counter-productive (Lustick, 2010).

**Beyond Questioning.** Wenning (2004) turns to another facet of inquiry and articulates, “…Indeed all science teachers must have a comprehensive understanding of the hierarchical nature and relationship of various pedagogical practices and scientific processes if they are to teach science effectively using and promoting inquiry” (p. 2). Table X below displays Wenning’s Model of Inquiry Processes outlining the different pedagogical practices within inquiry. Wenning (2004), Lustick (2010), and Kahn (2012) believe if teachers want to effectively use inquiry, they must train their students using

<table>
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<tr>
<th>Figure 2.1 Lustic’s Rubric for Assessing Focus Question Quality</th>
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<tbody>
<tr>
<td><strong>Question</strong></td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
</tr>
<tr>
<td><strong>Content</strong></td>
</tr>
<tr>
<td><strong>Context</strong></td>
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<tr>
<td><strong>Curriculum</strong></td>
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<td><strong>Cognition</strong></td>
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<td><strong>Total</strong></td>
</tr>
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successive steps that lead them toward higher levels of intellectual sophistication and greater levels of student’s locus of control. The table below moves from discovery learning through pure and applied hypothetical inquiry. The goal is to reach hypothetical inquiry, but generally speaking some researchers believe that this level of inquiry should be rarely used as students do not have enough content depth to perform free or hypothetical inquiry. Wenning (2004) relegates the top levels of inquiry for gifted students and labs conducted outside of regular class time. Throughout Wenning’s (2004) hierarchy, the teacher models inquiry and slowly fades to allow students to take over the intellectual work of inquiry. In essence the teacher bridges the gap between the levels of inquiry making them accessible to students similar to Vygotsky’s zones of proximal development.

<table>
<thead>
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<th>Figure 2.2 Wenning’s (2005) Model of Inquiry Processes</th>
</tr>
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<tbody>
<tr>
<td>Discovery</td>
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<tr>
<td>Low</td>
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<tr>
<td>Teacher</td>
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Finally, the NRC (2000) describes inquiry through five essential features: (a) learner engages in scientifically oriented questions; (b) learner gives priority to evidence in responding to questions; (c) learner formulates explanations from evidence; (d) learner connects explanations to scientific knowledge; and (e) learner communicates and justifies
explanations (p. 29). Each of these essential features find support in Wenning’s (2004) hierarchy of intellectual sophistication and locus of control. It is these ideas that provide the foundation for the inquiry and learner-centered continuums I created to use in examining teachers’ inquiry practices, and to a lesser degree, teachers’ learner-centered practices. Learner-centered practices are discussed more fully following this section on inquiry.

There have been many misinterpretations of inquiry and inadequate expressions of inquiry. Teachers have sometimes equated discovery, discussion and debate, projects, authentic problems, student-centeredness, and/or hands-on activities as inquiry. While all of these come into play in the inquiry-based classroom none of them alone are inquiry. Assay and Orgill (2010) characterize the role of inquiry as, it “puts emphasis on learners working under the guidance of experienced teachers to construct understandings of scientific concepts through interactions with scientific questions and data” (p. 59). Goodman and Bernston (2000), and Volkmann (2012) among others note that most students are not ready for full and open inquiry which necessitates students’ formulating their own questions, but need guidance and structure provided by the teacher to avoid frustration and perhaps failure.

Assay and Orgill (2010) list barriers to teacher adoption of inquiry: concerns about lack of control of student behavior; concerns that students are not capable of performing inquiry; teachers’ feelings that there is not enough time to cover the mandated curriculum using inquiry; inexperience with inquiry as part of their training; and not having been explicitly taught what inquiry looks like through the use of cases (59). They further conducted a literature review covering 10 years of the Science Teacher, the
publication of the National Science Teachers Association. They found that the least widely addressed feature of inquiry between 1997 and 2007 was the question process, even though experts argue that questioning is the sine qua non of inquiry-based practice.

**Learner-Centered Practices.** As the NRC describes the learner-centered classroom, it requires the following teacher knowledge, skills and abilities: how to assess students’ prior knowledge and understandings; how to engage students’ prior knowledge and understanding so students can either accommodate, assimilate, or create new knowledge and understandings; understanding of the broad ideas of Science and which concepts must be taught in depth; how to encourage doing for understanding; how to assess for student understanding rather than memorization of facts; how to employ metacognitive strategies to engage students in their own learning; how to use formative assessments that are learner friendly and which make students thinking visible; how to create an intellectually stimulating and psychologically safe classroom environment in which students may revise and improve their thinking; and how to create a learning community that engages and motivates learners (Gaebler & Schroeder, 2003).

Weimer (2002) provides 5 features of learner-centered practices: a. Balance of power between instructor and student; b. Use of content to develop skills of how to learn in the discipline, student’s awareness and confidence in their own learning; c. Teacher as facilitator or guide; d. Student takes responsibility for learning; and e. An evaluation system that promotes learning and self-reflection, rather than grades. The following discussion expands upon these features.

*Balance of Power.* Weimer sees power as a crucial issue in determining learner-centeredness. When power is balanced, there is a focus on both the students and the
instructor. How teachers express what happens in the classroom provides hints to their learner-centeredness (i.e., discourse is filled with I want, I did, I prepared, I would have liked this when I was in school, versus the students wanted/did/prepared/discussed etc). Both students and instructors are involved in evaluating learning. Students need opportunities to evaluate what they have done. The learner-centered classroom is often busy and noisy, filled with the hum of activity surrounding learning experiences and opportunities (National Capitol Language Resource Center, 2012; Weimer, 2002).

**Use of Content.** Weimer suggests the use of content not to merely cover material but to develop students’ abilities of how to learn in the discipline and to promote students’ metacognitive awareness, as well as confidence in their learning. She says, “We use content… as a vehicle to develop learning skills. This means we help students acquire a repertoire of strategies, approaches, and techniques that they can use when they need to learn material like that of the discipline” (p. 51). Emphasis in this area is on generating better questions and learning from errors (Teacher-Centered vs. Learner-Centered Paradigms, 2012).

**Facilitator/Guide.** The instructor role in a learner-centered classroom becomes one of a facilitator or guide rather than the sage on the stage. In classrooms where the teacher takes the role of facilitator, students talk without constant instructor monitoring, the instructor provides feedback or correction when questions arise (National Capitol Language Resource Center,), students are actively involved, and the instructor and students learn together (Teacher-Centered vs. Learner-Centered Paradigms, 2012).

**Students Take Responsibility for Own Learning.** Learner-centered instructors create a climate where students primarily take responsibility for their own learning. In
this climate, students work in pairs, in groups, or alone depending on the purpose of the activity. When questions arise, students answer each other’s questions, using the instructor as an information resource. Students are also given some choice of topics to cover and to research (National Capitol Language Resource Center, 2012). Finally, the classroom culture is cooperative, collaborative, and supportive (Teacher-Centered vs. Learner-Centered Paradigms, 2012). Weimer articulates that children need to be taught how to be life-long learners, and how to think. She further argues, “…until knowledge is explicit, it masters the learner rather than the learner’s mastering it” (p. 50).

_Evaluation to promote learning and self-reflection._ Learner-centered teachers use evaluation to promote learning and self-reflection, rather than generating grades (Weimer, 2002; National Research Council, 2000; National Science Teachers Association, 2004). Teaching and assessment are viewed as intertwined and not separate functions. Learning is assessed, more through papers, projects, performance, portfolios, and other means (Teacher-Centered Vs Learner-Centered Paradigms, 2012).

On the other end of the continuum lie teacher-centered practices. The following five characteristics describe teacher-centered practices:

- The teacher is the authority;
- The teacher determines content and organization of the course; emphasis is on acquisition of knowledge outside the content in which it will be used, emphasis is on right answers (Huba and Freed, 2000);
- Teacher is the model; only students are viewed as learners (Huba and Freed, 2000);
• Knowledge is transmitted from teacher to students; culture is competitive and individualistic (Huba and Freed, 2000); students are the recipients of the instructor’s knowledge and expected to take responsibility for learning what the instructor tells them they must learn; students passively receive information (Huba & Freed, 2000);

• The teacher evaluates student learning; teacher is primary evaluator; teaching and assessment are separate; assessment is used to monitor learning; desired learning is assessed indirectly through the use of objectively scored tests (Huba & Freed, 2000).

Inquiry and learner-centeredness are a mix of attitudes and actions ranging from full inquiry to absence of inquiry and student-centered to teacher-centered. Chapter 3 will explain how I used this idea of a continuum to develop criteria for quantifying the qualitative findings from the larger study from which this one was drawn.

This discussion naturally leads to one of the concerns of this study – alternative teacher certification. The difficulty most teachers have in developing inquiry-based and learner-centered practices calls into question the idea of alternative teacher certification, which allows teachers into the classroom as the teacher of record much earlier than traditional teacher education programs. Therefore, this next section discusses alternative teacher certification.

**Alternative Teacher Certification**

**Alternative teacher certification defined.** This study examined inquiry-based and learner-centered teaching among science teachers who have been prepared to teach
through alternative certification programs. Feistritzer (1998) defined alternative certification routes as the means designed to produce credentialed teachers ranging from emergency certification to very sophisticated and well-designed programs that address the professional preparation needs of the growing population of individuals who already have at least a baccalaureate degree and considerable life experience who want to become teachers (p.2). In 2005, she added that alternative teacher certification “refers to state licensing agencies that are alternatives to the traditional college, campus-based (usually undergraduate) teacher education program route culminating in a certificate (license) to teach” (p. 3). Additionally, and Humphrey and Wechsler (2005) defined alternative teacher certification as programs or licensing routes that allow persons to enter the teaching profession by earning a standard license or teacher certificate without completing a traditional 4- or 5-year university-based program” (p2).

Feistritzer and Harr (2008) proposed a definition based on similarities and differences between alternative routes and traditional teacher education routes,

Regardless of the terminology or acronym, “alternative ______” – in the context of teacher certification – refers to creations by state licensing agencies that are alternatives to the traditional college, campus-based undergraduate teacher education program route culminating in a certificate (license) to teach. The most accurate term to describe what is now going on at the state level is “alternative routes to teacher certification.” These alternative routes are designed for individuals who already have at least a bachelor’s degree – many of whom have experience in other careers – who
want to teach the subjects in areas where there is a demand for teachers (p 3).

Stoddart and Floden (1995) looked at other differences between alternative certification and traditional certification as defining features: the timing of training, the context of the training, and the mix of knowledge and skills deemed important. Other researchers (i.e. Ballou, Podgursky, Finn, Hanushek, and Adelman among others) focus on the rapid entry and into teaching and characteristics of enrolled candidates of alternative routes to teacher certification.

For the purpose of this study and given the definitions above, I will simply use the terms alternative teacher certification program/s (ATCP/s) when speaking about the programs attended by the teachers in this study and alternatively certified teacher/s (ACT/s) when speaking about the teachers in this study.

**Rationale for Alternative Routes and Programs.** According to proponents of alternative teacher certification, traditional teacher education does not guarantee quality teachers, but instead alienates many highly qualified individuals through unnecessary red tape. Specifically Hanushek (2002) challenges policy mandates stating,

The range of options being pushed forward include raising the course work requirement for teacher certification, testing teachers on either general or specific knowledge, requiring specific types of undergraduate degrees, and requiring master’s degrees. Each of these has surface plausibility, but little evidence exists to suggest that these are strongly related to teacher quality and to student achievement (p. 4).
Hanushek (2002) further claims that traditional paths towards licensing coupled with other measures (i.e. reducing class size) actually work to reduce the supply of high quality teachers by creating a need to increase the pool of high quality teachers. Further, he adds that resources diverted to hire more teachers because of smaller class size could be better used to fund other areas that could produce more significant results (i.e. create strong ATCPs). He and other proponents of alternative teacher certification argue that traditional certification acts as a barrier to students not wishing to take the seemingly irrelevant courses required for certification and in essence acts as a “ceiling on quality” (p. 4). Hanushek (2002) concludes that input policies have not guaranteed high quality teaching and therefore given their content knowledge expertise and prior professional work experience, alternatively certified teachers can be a viable source for increasing the supply of quality teachers. Further, ATCP proponents (i.e. Feistritzer and Harr, 2008; Finn & Madigan, 2001; Ballou & Podgursky, 1996, 2000) believe that alternate routes give school districts the opportunity to hire talented individuals with subject matter expertise, but who may not specifically have an education major in their undergraduate programs in college.

Purposes of Alternative Routes and Programs. The history of alternative teacher certification reveals two major purposes: to address concerns in the quantity and quality of teachers. Remarking on the purposes of ATCPs, McKibbin and Ray (1994) argued that ATCPs were “different approaches to expand the pool of qualified teachers to include persons who might not otherwise be able to become teachers,” rather than competing with and attempting to replace traditional teacher programs. As ATCPs evolved, more specific and local purposes were introduced: opening teacher training to
providers other than colleges or universities (Moore Johnson, Birkeland, & Peske);
increasing the number of minority teachers to reflect school populations
(Haberman, 1999; Brennan & Bliss, 1998); recruiting teachers to work in areas of need
such as hard-to-staff schools; filling specific shortages in content areas such as science,
math, special education, and ESL; giving districts more flexibility to recruit and hire
teachers especially in the urban districts with large minority populations that have been
hardest hit by the teacher shortage; and attracting higher-ability, more diverse,
experience people with subject matter majors (Zumwalt, 1996).

Koedel, Parsons, Podgursky, & Ehlert (2012, In press), note in a recent study that,
“virtually all of the variation in teacher effectiveness comes from within-program
differences between teachers…that is difference between graduates from different
traditional preparation programs are small and perhaps even non-existent” (abstract, np).
Koedel et al, also found that,

Graduates from the state flagship university in Missouri who end up
teaching in public schools have much lower ACT scores than other
students from the same university; alternatively, teachers from several
other universities look similar to students who do not go into teaching.
These findings offer at least a partial explanation for the recurring
empirical finding that educators from more selective institutions do not
systematically outperform educators from less-selective institutions (p. 4).

One could conclude from this that even the best teacher education programs, at
least in Missouri, are not graduating the pool of candidates that alternative certification
programs aim to attract. This means that the ATCPs in Missouri could be attracting higher caliber and more experienced individuals into teaching careers than their traditional counterparts.

**Common Factors of Successful ATCPs.** Wilson, Floden, and Ferrini-Mundy (2001) completed a review on 14 papers which reported on 11 studies documenting issues in alternative certification. From those papers Wilson et al defined the components and characteristics of high-quality alternative certification programs. Roth and Swail (2000) of the Education Policy Institute in Washington DC examined three studies on alternative teacher certification and presented their recommendations for strong alternative teacher certification programs. The National Commission on Teaching and America’s Future (1996) listed what they found to be characteristics of strong alternative certification programs. Moore-Johnson, Birkeland, and Peske (2005) examined 11 programs in three states and found four characteristics in common with all other researchers listed here.

Humphrey, Wechsler, and Hough (2008) studied seven programs and found that effective programs are selective, look for previous classroom experience, prepare timely coursework tailored to individual candidates’ needs, and provide trained mentors. They found that the variable that most affected outcomes was school context. None of the other studies listed here looked at that factor and therefore it may be that they would have agreed if they had included that in their analyses. Since Wechsler et al were the only researchers to examine this characteristic it is not included in the table below, but their finding seemed important enough to mention here and to use later during analysis of the data. Darling-Hammond and Baratz-Snowden (2007) also found seven important
characteristics of strong ATCPs. Wilkinson listed five components of effective alternative teacher certification citing four articles for those components.

Humphrey, et al (2008) concluded that “teacher development in alternative certification appears to be a function of the interaction between the program as implemented, the school context in which the on-the-job training occurs, and the career trajectory of the individual participant. All of these researchers and the characteristics they found important to the development of strong ATCPs are listed in the Table 4 below.

| Figure 2.3 Characteristics of Effective Alternative Teacher Certification Programs |
|---------------------------------|---------------------------------|----------------|----------------|----------------|----------------|----------------|
|                                 | Entry | Mentoring & Supervision | Pedagogical Training | Clinical Experiences | High Exit Standards | Strong Academic Prep | Well Designed Program |
| Wilson                          | X     | X                          | X                      | X                       | X                       | X                         | X                          |
| National Commission on teaching |        |                            |                        |                          |                          |                           |                            |
| and America’s Future (1996)     | X     |                            | X                      | X                       | X                       | X                         | X                          |
| Moore-Johnson, Birkland, & Peske| X     |                            | X                      | X                       | X                       | X                         | X                          |
| (2007)                          |        |                            |                        |                          |                          |                           |                            |
| Humphrey, Wechsler, & Hough     | X     |                            | X                      | X                       | X                       | X                         | X                          |
| (2008)                          |        |                            |                        |                          |                          |                           |                            |
| Darling-Hammond & Baratz-       | X     |                            | X                      | X                       | X                       | X                         | X                          |
| Snowden (2007)                  |        |                            |                        |                          |                          |                           |                            |
| Stafford & Barrow (1994)        | X     | X                          | X                      | X                       | X                       | X                         | X                          |
| Association of Teacher Educators| X     |                            | X                      | X                       | X                       | X                         | X                          |
| (1989)                          |        |                            |                        |                          |                          |                           |                            |
| Podgursky (2004)                | X     |                            | X                      | X                       |                         | X                         | X                          |
| Roth & Swall (2001)             |        |                            |                        |                          |                          |                           |                            |

*Pre-entry Screening includes minimum GPA standards, references, police checks, basic skills test, intensive interviews, broad liberal arts background, and direct experience with children and youth before entering program
**Mentoring/Supervision/On-going training includes counseling, mentoring from trained mentors, and supervision from ATCP and/or school of hire
***Well Designed Programs included sequenced course components, carefully constructed, timely, and tailored to individual backgrounds and school contexts

Themes that emerge from Table 4 in order of importance are:

- Careful recruitment and selection of candidates as a part of high entrance standards;
- Teaching experience either before entering the program or during the program before taking over a class as the teacher of record;
• Ongoing mentoring and supervision in the first year; pedagogical training in classroom management and discipline;
• Well designed programs demonstrating consistency throughout and with logical sequencing of courses; strong academic preparation of subject matter; and
• High exit standards.

The above characteristics will be used to help examine the ATCPs in this study and their impact on the outcome of teachers’ classroom practices.

Teacher Characteristics

Certain teacher characteristics are of interest to this study, specifically those presented by alternative certification proponents: maturity (age as a proxy), professional experience, and depth of related content knowledge. Because of findings from the larger parent study from which this study derived (Akiba & Scribner, 2010), I have also considered one other factor and that is whether or not teachers had education-relevant experiences, especially with youth that may have given them an advantage over other teachers with no such experience.

Proponents of alternative certification have theorized that a pool of career-changing individuals could be attracted into teaching if cumbersome red tape and useless hurdles would be removed from the track to gain teaching credentials. They also suggest that these career changers have a depth of knowledge, career expertise, and maturity that generalize to the classroom, but will give them the ability to stay the course of teaching and have less attrition than traditionally trained and usually younger students with less content depth, less professional experience, and consequently less overall maturity.
Akiba and Scribner (2010) found that teachers’ past education-relevant opportunities have been shown to give them a slight edge when entering teaching, if only because their student expectations were more realistic. For those teachers who pursued careers before entering teaching, the science content relevance should be relevant to depth of knowledge. It is the depth of knowledge which supports inquiry-based teaching.

Zientek (2007) found that alternative certification programs seemed to benefit those teachers above 40 years of age. Other literature has provided a distinction between traditional college age students (between 18 and 28) and non-traditional (above 28). This provided a background for quantifying the idea of maturity in teaching. Literature (Bransford, Brown, & Cocking, 2000; Ericsson, 1991, 1993, 1996) on expert and novice levels of performance has found that it takes, depending on the individual, approximately 10 years of full-time work to reach expertise. However, it has been noted that in the teaching field, 3-5 years seems to bring almost all teachers to a level of expertise with little noted improvement given more years of experience. Ericsson (1993) offers that most serious individuals reach a level that stops short of the full expert level and for those that continue on into the top levels of expertise; deliberate practice seems to be an important aspect of further improvement versus amount of time.

Program Contexts

The 8 programs in this study demonstrated variety in delivery, mission, length, consistency, sequencing of coursework, entrance and exit standards, coursework, and instructor modeling of inquiry-based instruction and learner-centered orientation. Table 5
below displays those program characteristics of the 8 programs and their variability.

![Program Similarities Table]

<table>
<thead>
<tr>
<th>Program</th>
<th>Entry GPA</th>
<th>Exit Requirements</th>
<th>Entry/Interview with screening process</th>
<th>Pedagogy</th>
<th>Inquiry</th>
<th>College Educator models inquiry</th>
<th>SEQ</th>
<th>Student Centered-ness Modeled</th>
<th>Science Methods Course</th>
<th>Individulized</th>
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**Social Context of Education**

The 8 programs in this study represented a full range of socio-economic status among the schools in which their teachers were employed. They ranged from almost no poverty to very high levels of poverty as explained below. Reports from the National Center for Education Statistics (1997) point to poverty as a powerful influence on school contexts. They report,

Research (Coleman et al, 1966; Kennedy, Jung, & Orland, 1986;) has shown that student performance is strongly related to the educational backgrounds and aspirations of other students in the school. This context or composition effect has been found to be particularly strong for low income students. For example, low income students in schools with small concentrations of such students have higher achievement and graduation rates than their counterparts in schools with high concentrations of low income students (p. 14)
Poverty brings with it a host of problems that impact student success, and novice teachers in these settings are not always prepared to deal with the facts of poverty outlined below by the National Center for Statistics (1996):

- Many single-parent families live in poverty. Children in single parent families are more likely to experience early school problems and are less likely to participate in early literacy activities than children in two parent families and single parent family homes usually have significantly lower resources.

- Poverty is associated with education level and parents’ education level is strongly associated with student achievement.

- Minority students are more likely than white students to attend high poverty schools.

- Public school teachers in high poverty schools are more likely to report that student misbehavior interferes with their teaching than are teachers in low poverty schools.

- Public secondary teachers in high poverty schools are more likely to report that student absenteeism and tardiness are serious problems in their schools than public secondary teachers in low poverty schools.

- Teachers in high poverty public schools are more likely than teachers in low poverty to report that verbal abuse of teachers and student disrespect of teachers are serious problems in their schools.

- An increasing percentage of high poverty public school teachers report that physical conflicts and weapons possession are moderate or serious problems in their schools.
• Fourth-graders in high poverty public schools are less likely to be in schools with
gifted and talented programs or extended day programs than fourth-graders in low
poverty schools.

• Students in mathematics classes in low poverty public secondary schools are more
likely to be taught by teachers who majored or minored in mathematics than were
students in high poverty public secondary schools.

• Public schools with high levels of students in poverty are less likely to be
connected to the Internet than schools with lower levels of student poverty.

• Teacher salaries are higher in low poverty public schools than they are in high
poverty public schools.

• Relatively low wealth public school districts spend less per pupil in general and
less on capital investment than do school districts with more wealth.

If poverty is an indicator of a less than optimal learning environment or an
environment not conducive to teachers’ mental and physical well-being, how then do we
specifically measure it, and how much poverty is too much poverty? The National Center
for Education Statistics (1996) states that, “the use of free or reduced-price lunches in
school is the most widely available and comparable measure of school poverty
concentration” (p. 14). They also provide breakpoints or cross-over points that can be
used for calibrating poverty concentration using percentages of free- and reduced-price
lunches, describing low poverty as those schools in which 5% or less of students are
eligible to receive free or reduced-price lunches and high poverty as those schools in
which 40% of students are eligible to receive free- and reduced-price lunches. These breakpoints will be further discussed in the methods section.

**Summary**

Returning to the focus of this paper, teachers’ instructional methods are expected to make a difference in positive academic outcomes for all students without consideration to socio-economic status or location. Given teacher shortages and student achievement gaps plaguing the US, it is important that every teacher is a quality teacher capable of using the best teaching methods regardless the route employed to acquire the necessary knowledge and skills. This study analyzes the instructional methods of 33 alternatively certified Science teachers in the state of Missouri to document their instructional methods looking for relationships between teachers, programs, and school contexts.

Figure 2.5, on the following page below, displays the relationships among the variables discussed earlier throughout this chapter.
Given the ever increasing levels of knowledge, skill, and ability required of teachers this study looks at the ability of ATCPs to produce teachers capable of meeting present day demands and requirements for inquiry-based instruction and student/learner-centered practices. However, advocates of ATCPs contend that carefully crafted ATCPs will indeed attract individuals capable of meeting these demands because of life
experiences that have nurtured generalizable skills from the marketplace to public school teaching.

CHAPTER 3
DESIGN AND METHODS

This study employed a mixed-model design entailing analysis of secondary data from a National Science Foundation Funded project which gathered both quantitative and qualitative data collected over a 3.5 year period from the summer of 2004 through December of 2007. The study included 8 alternative teacher certification case study sites, 30 school sites representing 28 districts and 33 science teachers over a period of 3 ½ years. This chapter describes the overall design of the study, including two analytical techniques not often used in educational research. Cluster analysis has long been used in the social sciences, but has not yet been seen as a useful tool in educational research; therefore, in this chapter I describe cluster analysis and provide a rationale for using it. Fuzzy set qualitative comparative analysis has roots in crisp-set qualitative analysis and has been used extensively in fields such as engineering, migrating to the social sciences most directly through Charles Ragin (1987).

My study was exploratory and looked at ATCP policy outcomes as measured through ATCP Science teacher graduates’ use of inquiry-based methods. It was concerned with the combination and connections of influences associated with program, teacher, and school context variables and the teachers’ inquiry-based and learner-centered instructional practices over time. Further my study aimed to add to the knowledge base on ATCP outcomes and inform policy-makers and teacher educators which variables and/or combinations of variables are associated with strong ATC Science programs.
Research Questions

This study is guided by three research questions:

- To what extent do alternatively certified science teachers use inquiry-based instructional practices and exhibit learner-centeredness?
  - How, when, and to what degree do alternatively certified teachers use inquiry-based practices?
  - To what degree and how are alternatively certified teachers learner-centered?
  - How do teachers cluster by their use of inquiry-based and learner-centered practices?

- How do alternatively certified science teachers’ use of inquiry-based and learner-centered practices change over time?
  - Where do teachers place on an inquiry-based continuum for each year observed?
  - Where do teachers place on a learner-centered continuum for each year observed?

- To what degree are teacher, program, and school factors associated with alternatively certified teachers’ use of inquiry-based and learner-centered practices?
  - How do teachers cluster by factors associated with teachers’ use of inquiry-based and learner-centered practices?
Previous Analyses

Several articles from the parent study data have been published in the last 5 years (Scribner & Akiba, 2010; Scribner & Heinen, 2009, 2010; Scribner) and early findings have been shared during annual conferences for the American Education Research Association and the American Education Society Association. Several of the findings are pertinent to this study: Teachers’ with career and life experiences that were education related rated higher on overall instructional practices, while career length, number of careers, and career relevance to subject area did not significantly impact instruction (Scribner & Akiba, 2010).

Heinen and Scribner (2007) and Scribner and Heinen (2009) looked more closely at the ATC programs’ in terms of bureaucratic discretion (2007) and program theory analysis (2009). Heinen and Scribner (2007) highlighted how programs widely differed within Missouri due to several factors: the state’s regulatory approach, relationships with school districts and external partners. Scribner and Heinen (2009) studied selected program features of the ATC programs in Missouri and found evidence supporting that variation among ATC programs is due to top-down (state policy) and bottom-up pressures (school and district relationships). More importantly, to my study, was their conclusion that large-scale studies tend to obfuscate the complexities and nuances revealed in the context of smaller studies that “ultimately define the quality of program implementation as it is actually carried out in practice” (p. 195).

These studies were mixed-method in design and grappled with the difficulty of statistically analyzing a small data set (less than 100 cases) to find significance or to have power. Another difficulty analyzing the programs and the teachers’ instructional
strategies is the linear basis of many statistical procedures. Not all relationships are linear and linear approaches may not find important relationships and/or configurations among variables. While the preceding studies did help to inform my study, they also provided a rationale for doing one more study on this particular data set.

With my study, I desired to look at possible combinations of variables – configurations – consisting of teacher, program, and school characteristics. The previous studies above did not look at all of these at one time, looking for possible configurations that could be associated with teachers’ instructional practices in their classrooms.

**Research Design**

I used both qualitative and quantitative techniques to analyze the NSF Study data to address my research questions and to help meet the criteria for evaluating the “goodness” of my answers. Tashakkori and Teddlie (1998) state, “the mixed-method approach allows studies to utilize quantitative measures and hypotheses while also exploring in greater depth the processes by which the relationship occurred” (p.14).

**Rationale for a Mixed-Model Study.** Obwuegbuzie and Teddlie (2003) suggest two major rationales for a mixed model approach: representation and legitimation. They explain representation as the ability to extract adequate information from underlying data and legitimation as the validity of data interpretation. To extract adequate information, data must be deep and broad (Babbie, 2008). The underlying data in my study are both deep and broad. Data were drawn from multiple sources over a three-year period and included approximately 130 total hours of classroom observations (usually one hour long), and 130 total interviews lasting from 30 minutes to 1.5 hours each. I used multiple
sources of data – interviews, observation notes, and collected artifacts – to adequately describe and analyze what happened in the ATC Science teachers’ classroom, what configurations of variables were associated with levels of inquiry-based and student-centered practices, and what appears to influence the teachers’ choice of instructional methods.

**Purposes of Mixed-Model Studies.** Greene, Caracelli, and Graham (1989) outline five purposes of mixed model studies: triangulation, complimentarity, development, initiation, and expansion. A study can focus on one or more of these purposes, of which my study utilizes triangulation, complimentarity, and initiation.

**Triangulation.** Denzin (1978) divided triangulation into four types, two of which my study employs: methodological, which is the use of multiple methods to study and analyze the research problem. The data used in my study were primarily of a qualitative nature, consisting of semi-structured interviews, surveys, a post-observation rating scale, and naturalistic observations with accompanying field notes. Other data collection involved using ATCP websites and the Missouri Department of Elementary and Secondary Education’s (MODESE) website to gather both qualitative and quantitative data (i.e., ATCP mission statements, overviews of ATCP programs, percentages of specific demographic variables, etc.)

The data were analyzed using descriptive quantitative techniques including cluster analysis with its accompanying figures and charts to examine teachers’ characteristics; ATCP quality; and school contexts. Qualitative techniques – comparative analysis -- were used to deeply examine the clusters produced through cluster analysis and to create
continuums for further qualitative analysis. Calibration techniques from fuzzy-set qualitative analysis were used to quantify qualitative data.

**Complementarity.** Complementarity is the examination of overlapping and different facts of a phenomenon. Teaching is a multifaceted and complex endeavor with overlapping elements and combinations of factors that affect what teachers do or don’t do. In this study I am looking for non-linear combinations of variables or configurations that can be associated with teachers’ use of inquiry-based and learner-centered practices.

**Initiation.** Initiation involves the discovery of paradoxes, contradictions, and fresh perspectives. The outcomes of my study revealed paradoxes, contradictions and fresh perspectives. I was specifically looking for a fresh perspective on the factors that influence teachers’ use of inquiry-based and student-centered practices. I also utilized a different way of analyzing the outcomes of ATCPs by using two procedures not often employed in educational research: cluster analysis and fuzzy-set qualitative comparative calibration.

Stake (2010) says that the best qualitative research is seldom about how people feel, but rather how things happen, how they work. Happenings are experienced, and the researcher needs to probe (using triangulation) the assertions (teachers remarks about self in interview) until the experience is credible (p. 63). He goes on to say that multiple interpretations provide depth of understanding (p. 66). My study uses analysis/interpretations of observations, interviews, and other data to gain a deeper understanding of what was happening in the classrooms of the alternatively certified science teachers in my study. I have included information from observations and quotes from the teachers that flesh out the analyses I performed with the focus of giving the
reader a fee for how things happened in these classrooms as Stake noted, “episodic and situated description of the activity gives the reader a vicarious experience of happenings (p. 68).

**Participants and Data Collection**

**Participants.** Teacher participants for the parent study were selected from lists of ATCP enrolled students provided by 19 ATCPs located throughout the state of Missouri. To ensure homogeneity of teachers instructional skills for comparison purposes at the start of the study, participants selected for this study had to be enrolled in an ATCP for Science and could not have taught for more than 1 year prior to entering their ATC program and must have entered their ATCP no earlier than 2003. Not all ATCPs in Missouri were active nor did all programs have teachers that fit the criteria to take part in the project at the beginning of the larger study, hence participants came from a total of 8 different programs.

With the lists from the ATCPs, 232 teachers were identified as potentially eligible for our study. The team attempted to contact all eligible teachers through phone calls and emails. Teachers were also solicited for participation during program classroom observations by the observers. Out of the 232 eligible participants, 185 were contacted and 125 consented to participate. Initially, this represented a 54% participation rate of the entire population identified for the study. Teacher attrition rates from the ATCPs and during the first year of the study reduced the pool of teachers to 85. Continued attrition rates reduced the pool to 75 teachers by the third year. Further, complete data was only
collected on 54 teachers as some teachers only taught for one year and some only for two years.

Out of the pool of 75 teachers, 38 were science teachers. From that pool of 38, I selected 33. I dropped two teachers that were teaching in English Language Learner (ELL) classes without appropriate training, I dropped another teacher that had been interviewed only, and I dropped two others that discovered had been teaching in for more than 1 year as I read through their interviews, disqualifying them from my study as they did not fit the criteria for the parent study and consequently they did not fit the criteria for my study either.

**Data Collection Methods.** Data collection was performed over a three year period from January 2004 through December 2007 and included interviews of officials at Missouri’s Department of Elementary and Secondary Education (DESE), alternative teacher certification program (ATCP) site directors, ATCP program site instructors, and pre-service teachers enrolled at the ATCP sites.

Data collection instruments consisted of: an interview protocol for conducting interviews with teachers, program directors, and program instructors, a field note write-up protocol, a teacher survey, and a post-observation protocol on which to rate the teachers’ instructional practices during the time of the observation. Of those instruments this study utilized the interview protocol with transcribed interviews of ACTs, ATCP program directors, and ATCP instructors and the field note write-up protocols on teachers’ and instructors’ practices. Interviews with program directors and instructors took up to 2 hours and were performed at the beginning of the study. Five directors and approximately 20 instructors were interviewed and observed. Interviews were semi-
structured and opened ended, lasting from 30 minutes to 1.5 hours and all were transcribed.

Observations of ATCP classes in session were completed during the first year of data collection. Observations of ATCP instructors occurred once during the project. Detailed field notes were taken and transcribed using an observation template. Observations of teacher participants occurred three times over a three year period. Field notes were taken and transcribed using an observation template. All transcribed observations were reviewed by project personnel for clarity, focus, and adherence to the observation template organization and focal points.

Observations of ATCP participating teachers who were already engaged in teaching either as interns or as teachers of record were completed over a 3 ½ year period with three planned observation points of each teacher in the classroom. At observation points the teachers were interviewed and surveyed with a total of three planned interviews and surveys. Observations began in the fall of 2004 and finished in December of 2007.

Documents when available were gathered at program sites and at teachers’ school sites for detailed information about each program and school contexts. Documents with information pertaining to program goals, objectives, curriculum frameworks, students’ programs of study, and strategic plans were collected. These documents included syllabi, handouts from the instructors, program brochures, and copies of handouts from pre-service teacher presentations. Documenting materials were also gathered from the teachers at observation points. These documents included syllabi, handouts for students, copies of instructional materials, and documents about the schools themselves. Data were
also collected on the ATCP websites to fully describe them qualitatively and quantitatively.

**Data Collection Instruments.** Interview protocols were adapted from pilot instruments used in the research. Instructor interviews focused on the purposes, goals, and objectives of coursework and integration with field experiences (see Appendix A for a copy of the interview protocol).

The observation template was used to organize information from observers’ field notes (see Appendix B for a copy of the observation template) and was adapted from previous protocols developed for the NSF Local Systemic Initiatives projects (Horizons, 2003) and the enhancing Missouri’s Instructionally Networked Teaching Strategies (eMINTS) project (Bickford, et al, 2001).

**Data Analysis: Cluster Analysis and Fuzzy Sets**

I used both quantitative and qualitative analysis for triangulation purposes. Those analyses are: cluster analysis, qualitative comparative analysis, fuzzy-set qualitative comparative analysis. I quantified qualitative concepts to measure teachers’ practices and growth. I then qualitatively analyzed the quantitative outcomes of teachers’ practices and growth over time.

**Cluster Analysis.** Cluster analysis is a term used for numerical procedures to classify or to reveal homogenous groups within a sample of data into meaningful sets that aid in the development of theories within a given context (Everitt, Landua, & Leese, 2001). Clustering methods can be used to:

- develop a typology or classification
investigate useful conceptual schemes for grouping entities

- generate hypotheses through data exploration, and
- test hypotheses, or determine if types defined through other procedures are in fact present in a data set (Aldenderfer & Blashfield, 1984, p. 9)

According to Aldenderfer and Blashfield (1984) Five basic steps characterize all cluster analysis studies:

- Selection of a sample to be clustered
- Definition of a set of variables on which to measure the entities in the sample
- Computation of the similarities among the entities
- Use of cluster analysis method to create groups of similar entities
- Validation of the resulting cluster solution (p. 12)

Limitations are inherent in cluster analysis: (a) Most cluster analysis methods are relatively simple procedures that in most cases, are not supported by an extensive body of statistical reasoning; (b) cluster analytic methods have evolved from many disciplines and are inbred with the biases of these disciplines; (c) different clustering methods can and do generate different solutions to the same data set; and (d) the strategy of cluster analysis is structure-seeking although its operation is structure-imposing (Aldenderfer & Blashfield, 1984, pp. 15, 16).

The choice of which variables to use is one of the most important steps in the use of cluster analysis. The choice of variables should be guided by theory which is used to support the classification (Aldenderfer & Blashfield, 1984, p. 20). In many studies, variables are standardized to prevent substantially different units of measurement from
unduly influencing outcomes, and standardization is specifically recommended when using Euclidean distance. Frequently factor analysis is employed to reduce “dimensionality of the data, thereby creating new, uncorrelated variables that can be used as raw data for the calculation of similarity between cases” (Aldenderfer & Blashfield, 1984).

Seven families of clustering methods have been developed: (a) Hierarchical agglomerative, (b) Hierarchical divisive, (c) Iterative partitioning, (d) Density search, (e) factor analytic, (f) Clumping, and (g) Graph theoretic. Of these the three most used in the social sciences are hierarchical agglomerative, iterative partitioning, and factor analytic (Aldenderfer & Blashfield, 1984).

Hierarchical agglomerative clustering is recommended by SPSS (SPSS, ND) for use with small data sets and was used in this study. “Agglomerative hierarchical clustering begins with every case being a cluster unto itself. At successive steps, similar clusters are merged” (SPSS, ND, p. 364) and ends with all cases in one cluster. Hierarchical agglomerative clustering employs several linkage rules: single linkage or nearest neighbor, complete linkage or furthest neighbor, average linkage, and Ward’s method. Single linkage forms clusters by joining cases if at least one of the members of an existing cluster is of the same level of similarity. In complete linkage members must be within a specific level of similarity to all other members to be included in that cluster. Average linkage computes an average of the similarity of a case under consideration with all cases in the existing cluster and subsequently, joins the case to that cluster if a given level of similarity is achieved using this average value. Ward’s method optimizes the
minimum variance within clusters. Ward’s method works by joining cases to groups that result in the minimum increase in error sum of squares.

Distance measures use dissimilarities (similarities) or distance between objects when forming clusters. The most straightforward and most used method is Euclidean distance, which is the geometric distance in multidimensional space. Euclidean and squared Euclidean distances are usually computed from raw data, and not from standardized data. Squared Euclidean distance is used to place greater weight on objects that are further apart (StatSoft, ND).

Several approaches to determine the actual number of groups after analysis exist: (a) subjective inspection of the levels of the dendogram, (b) a scree plot displayed as Graph 2 below, (c) graph the number of clusters implied against the fusion coefficient – the numerical value at which various cases merge to form a cluster. A marked flattening in this graph suggests that no new information is portrayed by the following mergers of clusters (see diagram below); and (d) examine the values of the fusion coefficients to discover a significant “jump” in the value of the coefficients.

Figure 3.1 Scree Plot
The rules for determining the number of clusters present should be used in conjunction with an appropriate validation procedure. Five techniques for validating a cluster analysis are: cophenetic correlation, significance tests on variable used to create clusters, replication, significance tests on external variables, and Monte Carlo procedures (Aldenderfer & Blashfield, 1987).

Aldenderfer & Blashfield offer 5 guidelines in reporting cluster analysis: (a) An unambiguous description of the clustering method; (b) The choice of similarity measure should be clearly stated; (c) The computer program used should be stated; (d) The procedures used to determine the number of clusters should be explained; and (e). Adequate evidence of the validity of the cluster analysis solution should be presented.

**Fuzzy Set Analysis.** I am introducing fuzzy-set qualitative comparative analysis (fsQCA) here as the technique that I used to quantify the qualitative concepts used in creating the continuums and for the variables used in the cluster analysis.

Fuzzy-set qualitative comparative analysis was developed by Charles Ragin whose frustrating experiences trying to answer questions not well suited to multivariate statistical techniques led him to find a method to answer his research questions. He began with the idea of a data reduction technique “to simplify complex data structures in a logical and holistic manner” (Ragin, 1987, p. vii). Ragin (1987) developed a Boolean algebra approach “which used categorical variables; looked at different combinations of conditions” could be “applied to categorical dependent variables; and involved data reduction” (p. xi).

Specifically fuzzy refers to varying degrees of membership in a set moving beyond conventional dichotomous sets, by permitting membership in the interval
between 1 and 0, with 1 and 0 still maintaining the dichotomous 1 = full membership and 0 = full non-membership. The fuzzy set of student-centered teachers (or people with brown hair, or at-risk families, or quality teaching) could include those who are fully in (=1), those who are mostly in (=.90), those who are neither more-in or -out (.50), those who are almost in, but more out than in (=.40), and those who are fully in non-membership (=0). It is the researcher who assigns fuzzy membership using theory that is open and explicit so other researchers can evaluate the assignment of values in a fuzzy set (Ragin, 2000).

Fuzzy sets are used in multiple fields to address many different questions and problems, from artificial intelligence to “smart” machines, to the stock market. Ragin (2000) contends that the use of fuzzy sets makes a richer dialogue between ideas and evidence. Ragin (2000) provides three arguments to consider:

- Social scientists interested in discovery must relinquish many of the “homogenizing assumptions” that undergird conventional quantitative analysis.
- The fuzzy-set approach searches for heterogeneity within “given” or pre-constituted populations and conceives of “difference” in terms of kinds and types of cases, replacing the conventional view of difference as variation (i.e. as deviation from the mean). Fuzzy-sets augment the configurational approach by allowing degrees of membership in types and kinds. Thus, the incorporation of fuzzy sets allow for “variation” without forsaking the core emphasis on types and kinds of cases.
The link between theory and data analysis can be greatly improved using fuzzy sets for the simple reason that fuzzy sets can be carefully tailored to fit theoretical concepts (p. 5 & 6).

Fuzzy sets are not merely continuous variables. For example, consider a measure of inquiry-based teaching. Inquiry-based teaching is based on five features outlined by the NSF (1996). Where on this scale is full membership in inquiry-based teaching? Where is full non-membership in inquiry-based teaching? Where on this scale is the break-point or cross-over point separating those teachers who are more in the set of inquiry-based teaching and those who are more in the set of full non-membership of inquiry-based teaching? To answer these questions, it was necessary to acquire a good base of substantive knowledge about inquiry-based teaching and of its theoretical relevance as well as other variables investigated in this study – learner-centered instruction, school context, program context, and teacher characteristics (Ragin, 2000, p. 9).

For this study, the National Science Foundation, National Science Teachers Association, and Science for All Americans literature provided the theory and knowledge to construct two continuums, one of inquiry-based and one of student-centered instructional practices ranging from full inquiry to absence of inquiry. Teachers’ inquiry-based and student-centered practices were analyzed for level of inquiry-based and student-centered practices in the classroom using interviews and observations and quantified using fuzzy-set theory and calibration methods. Teachers were then placed on
these two continuums as individuals, as aggregated groups on the program level, and as clusters based on their practices.

Outcomes of the analysis of the teachers’ practices were then used in the final analysis to understand the variables associated with teachers’ use of inquiry-based practices: (a) teachers’ level of maturity (age as a proxy), and their career backgrounds—relationship of professional experience to teaching and amount of education-relevant experience during career; (b) the teachers’ ATCP characteristics including entrance and exit standards, sequencing of coursework, inquiry methods courses, individualization of program, and field experiences; and (c) the teachers’ hiring school context variables of school support and socioeconomic variables – percentage of free and reduced lunches.

Teacher, ATCP, and School characteristics were used to analyze and discuss the teachers’ inquiry-based practices to understand the relationship between specific these variables and teachers’ growth in- and levels of teachers’ inquiry-based practices – using the time-series growth graphs and the inquiry-based instructional groups.

To answer research question 1, data analysis included the following 5 steps:

1. Create Inquiry-Based Continuum on which to place teachers; Create Teacher-Centered Continuum on which to place teachers; and Use the teachers’ placement on the continuum to group the teachers.

2. Using the inquiry-based continuum place teachers on the continuum and plot coordinates; and using the learner-centered continuum place teachers on the continuum and plot coordinates;
3. Combine the two continuums to create a plane with quadrants. Discuss the quadrants on which the teachers’ lie, in terms of their inquiry-based teaching and learner-centeredness and look for patterns in plotted data and analyze patterns;

4. Using all data, create teacher profiles to analyze patterns and discuss quadrants. Use a representative sample from the inquiry-based and learner-centered scale groups from the continuum plane to discuss the outcomes of plotting the teachers on the continuum plane; and

5. Compare and contrast outcomes of all previous steps. Discuss findings, conclusions, and recommendations.

To answer research question 2, data analysis included the following 4 steps:

1. Use the inquiry-based and learner-centered continuums created during analysis of Question One, Step One to create time series graphs representing teachers’ growth patterns in inquiry-based instructional practices and learner-centered orientations;

2. Create tables representing teacher, school, and programs and with these create teacher, school, and program profiles;

3. Discuss trend lines by teacher clusters, programs, and individual teachers

4. Use all of the above in the final analysis and discussion to compare and contrast outcomes of all previous steps.

To answer question 3, data analysis included 5 steps:

1. Use fuzzy-set calibration techniques to quantify teacher, program, and school characteristics;

2. Run cluster analysis and decide on number of clusters;
3. Analyze clusters looking for common threads in clusters and determine the meaning of clusters in relation to teachers’ instructional practices and learner-centeredness;

4. Discuss clusters;

5. Compare, contrast, and discuss findings in conjunction with other questions findings. Discuss implications, and to derive recommendations and conclusions.

Creating Fuzzy Sets. Each variable used in all of the analyses of this study were quantified using fuzzy set calibration techniques. Quantitative variables were recalibrated using fuzzy set calibration techniques. The variables calibrated using fuzzy set calibration included the following: teacher characteristics, program characteristics, and school characteristics. Teacher characteristics consisted of: past career experiences related to science content; prior career and/or other experiences that were education relevant; teachers’ length of time in a specific career or position, and teachers’ ages. Program characteristics included: entrance and exit requirements; sequenced coursework; focus on inquiry-based instruction and learner-centered orientations. School characteristics included: socio-economic-status (free and reduced lunch percentages were used as a proxy).

Fuzzy sets are created by using an interval between 1 and 0. In calibrating all of my variables, 1 indicated full membership in the concept, while 0 indicated full non-membership. It is the relevant literature that guided my definition of each qualitative variable’s placement in full membership or full non-membership. Likewise, with variables of a quantitative nature, the literature guided the placement. For instance in the set of full membership in low poverty schools, the literature indicated that when 5% or
less of the students within a school receive free and reduced lunches, that school’s status is low poverty. However the point of full non-membership in low poverty is not 100% free and reduced lunches, it is at the 40% level that a school is in full non-membership of low poverty schools.

After I located the points of full membership and full non-membership I had to locate what Ragin called the mid-point or cross-over point. This is the point that is neither in nor out of membership or non-membership. Again it is the literature that suggests where that point is. For teachers’ age, at first, I considered using a continuous fuzzy set placing the teachers from 0-1 based on years of age. However, what age was equal to 0 and what age was equal to 1? It was necessary to find the relevance of teachers’ ages in the literature. Several pieces of literature supplied important break-points. Research has shown that alternative certification programs seemed to benefit teachers 40 and over the most. That became the set of full membership. All teachers 40 and over were given the designation of 1 on the interval. Other break points of interest were noted in the literature such as: the traditional college age of 18-25 and the non-traditional age group of 26-38. These groups may have been interesting to study, but I opted for using only full membership and full non-membership to keep the analysis simple and based on the benefit of alternative teacher certification.

Creating Fuzzy Sets. For each variable I used the following procedure:

1. Name the variables that make up that group;
2. Explain how I calibrated each fuzzy set in the order the variables were first listed
3. Explain which fuzzy value set of Ragin’s that I will use and its break points
4. Explain each value’s meaning (i.e. a value of 1 = full membership and the definition of full membership of the specific variable being measured).

If the variable had already been quantified or was a quantitative variable, the original scale is explained (i.e., Those teachers originally rated 0 had no career or volunteer experience in a science content area or for a quantitative variable: Teachers’ professional expertise level was rated using Ragin’s continuous-value fuzzy-set placing years of experience on a continuous line from 0 – 1, with 0 equaling less than a year of experience, .1 = 1 year, .2 = 2 years and so on with 1 equaling 10 or more years. Ten years is the amount of time deemed necessary to reach expert levels through full-time work). For more in depth descriptions of the variables see pages 36 – 44.

**Teacher Characteristics.** In the literature review, the following teacher characteristics were considered important in understanding how and why teachers choose to use specific instructional practices: (a) teachers’ prior career experiences related to science content; (b) Prior career and/or other experiences that were education relevant; (i.e., youth pastor, drug counselor, teacher aide, substitute teacher, corporate trainer, etc.); (c) teachers’ time in career indicating levels of expertise in their career and content field; and (d) teachers’ ages.

**Prior Career Experiences Related to Content.** Prior Career experiences related to content were calibrated using Ragin’s 4-value fuzzy-set: 1 = fully content relevant, .67 = more content relevant than not, .33 = some content relevance, but mostly not, and 0 = not content relevant. Content values were calculated from interviews with the teachers who were questioned about their past careers and the content area of their degree. Teachers
with highly relevant careers and degrees to the content they were teaching were given a rating ranging from 0 – 3. Those scores were calibrated into a four-value fuzzy set.

A value of 0 was calibrated to a fuzzy set value of 0 corresponding to those teachers fully out of the set of teachers with relevant content career experiences. A value of 1 was calibrated to a fuzzy set value of .33 corresponding to those teachers more out than in the set of teachers with relevant content career experience. A value of 2 was calibrated to a fuzzy set value of .67 corresponding to those teachers who were more in than out of the set of teachers with relevant content experiences. A value of 3 was calibrated to the fuzzy set value of 1 which corresponded to those teachers in the set of teachers with relevant content experiences.

Those teachers originally rated 0 had no career or volunteer experience in a science content area. Those teachers originally rated 1 had little or no career or volunteer experience in a science content area. Those teachers originally rated 2 had more career or volunteer experience in a science content area. Those teachers originally rated 3 had the most career or volunteer experience in a science content area. The ratings for these experiences were developed by the principal investigators of the original NSF study previously mentioned.

**Teachers’ Education-Relevant Experiences.** I used Ragin’s four-value fuzzy set to calibrate teachers’ education-relevant experiences. This fuzzy set membership extended from 0 – 1. A value of 1 denoted the degree of membership labeled “fully in” in the set of teachers with education-relevant experience as described previously in this paper. A value of .67 denoted the degree of membership labeled “more in than out” of the set of teachers above the cross over point of the set of teachers with previous education-
relevant experiences. A value of .33 denoted the degree of membership labeled “more out than in” in the set of teachers with past education-relevant experiences. Finally a value of 0 denoted the degree of membership labeled “fully out” of the set of teachers with past education-relevant experiences.

**Teachers’ professional expertise level.** Teachers’ professional expertise level was rated using Ragin’s continuous-value fuzzy-set placing years of experience on a continuous line from 0 – 1, with 0 equaling less than a year of experience, .1 = 1 year, .2 = 2 years and so on with 1 equaling 10 or more years. Ten years is the amount of time deemed necessary to reach expert levels through full-time work. However, it has been noted that in the teaching field, 3-5 years seems to bring almost all teachers to a level of expertise with little noted improvement given more years of experience.

The teachers’ professional expertise fuzzy set extended from 0 to 1. The degree of membership for a value of 0 is labeled fully out of the set of experts. Values above 0 to below .5 had a degree of membership in the set of experts that was more “out” than “in”. Values of .5 were neither “in” nor “out” of the set of experts. The degree of membership for values above .5, but below 1 were said to be more “in” than “out”. Teachers’ age was calibrated by converting age to percentages which fit Ragin’s continuous fuzzy sets. A teacher with ten or more years of experience was considered to have 100% membership in the set of teachers with expert level with a corresponding value of 1 on the fuzzy set scale. A teacher straight from college with no intervening career was considered to have 0% membership in the set of experts with a corresponding value of 0. Teachers with 5 years were considered to be neither in nor out of the membership of the set of experts, the
cross-over point. Teachers with 2 years of experience were considered to have 20% membership in the set of experts with a corresponding value of .2.

**Teachers’ ages.** Teachers’ age groups were based on whether or not teachers fell into the group that Zientek (2007) found to most benefit from the ATC route. Teachers 40 and above were given a 1 and those 39 and below were given a 0. The degree of membership for the value of 1 was labeled fully in the membership of those teachers 40 years-old and above. The degree of membership for the value of 0 was labeled fully out of the membership of those teachers 40 years-old and above.

**Program Characteristics.** In the literature review, successful ATC program characteristics were discussed. Program characteristics deemed important to this study and also for which sufficient data allowed analysis were: entrance and exit requirements; sequenced coursework; focus on inquiry-based instruction and learner-centered orientations.

**Entrance and exit requirements.** Entrance Requirements consisted of GPA. GPAs ranged from 2.00 through 2.75. A GPA requirement of 2.50 was the cross-over point between membership in or out of the set of high entrance standards. Programs with a 2.50 GPA requirement were considered neither in nor out of the set of programs with high entrance requirements. A GPA requirement of 2.75 was considered to have 100% full membership in the set of programs with high entrance standards. A GPA of 2.00 was considered to have 0% membership in the set of programs with high entrance standards. Exit Requirements consisted of portfolios and action research projects. If a program required either a portfolio or an action research project they were considered on the cross-over point. If a program required both of these, they were considered fully in the
membership of programs with high exit standards. If a program did not require either of these, they were considered fully out of the membership of programs with high exit standards. Programs considered fully in the membership of programs with high exit standards were given a score of 1. Programs considered neither in nor out of the set of programs with high exit standards were given a score of .50. Programs considered fully out of the set of programs with high exit standards were given a score of 0.

*Focus on inquiry-based instruction and learner-centeredness.* Programs that focused on and demonstrated inquiry-based instructional practices were rated as a 1 and those that didn’t were rated 0. Programs with a 1 were considered to have 100% membership in the set of programs demonstrating and focusing on inquiry-based practices. Those programs given a rating of 0 were considered to have 0% membership in the set of programs focusing and demonstrating inquiry-based practices. If Programs focused on and demonstrated learner-centeredness they received a score of 1 and if they did not they received a score of 0. Those programs receiving a rating of 0 were considered to have 100% membership in the set of programs focusing on and demonstrating learner-centeredness, while those programs receiving a rating of 0 were considered to have 0% membership in the set of programs focusing on and demonstrating learner-centeredness.

*Sequenced coursework.* Programs were rated as either sequencing their coursework or not sequencing their coursework. Programs receiving a 1 sequenced the majority of their coursework and programs receiving a 0 did not sequence their coursework. Programs that sequenced their coursework were considered to have 100% membership in the set of programs that sequenced their coursework and programs that
did not sequence their coursework were considered to have 0% membership in the set of programs that sequenced their coursework.

**School Context.** The importance of school context has been well documented. School context covers a broad range of characteristics that impact teachers’ choices over time. One important measure of schools’ contexts as explained previously is socio-economic status (SES) levels. To calibrate school context, I used the National Center for Education Statistic breakpoints. They used a measure to determine low poverty and high poverty. They defined low poverty schools as those with 5% or less of students eligible to receive free- and reduced-price lunches (FRL) and high poverty schools which they defined as those with 40% or more of students receiving FRLs.

For calibration purposes it was necessary to establish a midpoint or a crossover point designating when schools where neither in nor out of either full membership in low poverty or full non-membership in low poverty. The National Center for Education Statistics also provided information that for every 10% more students receiving FRL, schools are impacted negatively in student performance. I used this figure to help find the crossover point in the set of low poverty and high poverty schools. The final calibrated set has four values: 1, .67, .33, and 0. The data set for FRL runs from 0 % FRL to 90% FRL. And since 40% indicates a school SES as being fully out of the indicator of low poverty, calibrating is not a one-to-one correspondence.

Schools with a FRL percentage of 40% and higher are calibrated to 0 and all schools with a 5% and below are calibrated to 1, there is left a range between 5% and 40% in which schools fall between. To find the midpoint for these schools, I used the 10% change indicated above. The 10% change in FRL did not divide neatly given a range
of 35 percentage points. To determine an approximate midpoint increasing poverty levels 10% at a time starting at 5% resulted in natural breakpoints at 15%, 25%, and 35%, leaving a remainder of 5%. Adding 2% to each resulted in more even breakpoints at 5, 17, 29, and 40. The midway point between 17 and 29 is 23, which I used as the crossover point to decide at one point a school moves out of the set of schools above negative poverty influences. So all schools with students receiving between 23% and 5% FRL were calibrated to .67 and schools with students receiving more than 23% and less than 40% FRL were calibrated to .33. Data on schools FRL percentages were gathered from the Department of Elementary and Secondary Education’s on-line data portal. The two private schools in the study published FRL percentages on their website.

**Creating the Continuums**

Creating the continuums required 3 major steps: 1. Create the inquiry practices continuum; 2. Create the learner-centered continuum; and 3. Combine the two continuums to create a plane with an X and Y axis.

**Inquiry practices.** Inquiry practices were calibrated using the NRC’s 5 essential features of inquiry calibrated to 0 – 1. Tables X and X below shows how this was completed. After reading through available educational research literature on inquiry, I decided to use the NRC’s five essential features of inquiry (Table 5, below) to develop and structure a continuum for inquiry-based practices, because those essential features seem to best represent inquiry to its fullest extent. I did not use the levels of inquiry as suggested by the NRC’s (2000) Table (p. 29), since these were merely variations of each
essential feature and I was measuring the extent of teachers’ ability to use all five features to achieve either full or partial inquiry without consideration to the variation of use.

At first, to develop the continuum, I considered the five essential features of inquiry as all equal to each other. After conversing with Dr. Volkmann (2012) and considering the importance attached to one of the features, I chose to consider feature number 1 a feature that must be present on all levels of inquiry, because in full inquiry, feature 1 drives the entire inquiry. Without feature 1 (the presentation of a substantive question that students spend time answering through research, data collection, pondering of evidence, basing explanations on that evidence, and communicating explanations) the rest of the features have no foundation upon which to evolve and become exercises standing alone. The other features are important, but it is possible for them to appear in different combinations, hence, the more features included in a lesson the higher the rating on the continuum.

Table 6, below, displays the continuum, along with the calibration to fuzzy sets (numbers ranging from 0 through 1), which were used to place teachers inquiry-based practices on the X axis representing the continuum. To receive full membership (1) all five features of inquiry had to be present and to receive full non-membership (0) all five features had to be absent. To create the cross-over point (.50), the point that is neither full
inquiry (full membership) nor absence of inquiry (full non-membership), only feature 1 could be present. The fuzzy set values in-between 1 and .5 were based on the presence of feature 1 and how many other features were missing or conversely how many were present. The fuzzy set values between .5 and 0 were based on the absence of feature 1 and how many other features were missing or conversely present. This aligns with the NSF’s (2000) concept of partial inquiry, though the NSF did not derive values for how many features could be present and how many had to be absent before it could not be called partial inquiry. I used fuzzy set calibration to derive the breakpoints (see discussion on fuzzy sets in the literature review section on fuzzy set calibration techniques, p. 40).

<table>
<thead>
<tr>
<th>Figure 3.3 Essential Features of Inquiry with Calibration</th>
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<tr>
<td><strong>Fully In / None of the Essential Features are missing</strong></td>
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</table>

**Learner-Centered Practices.** Learner-centered practices were calibrated using Weimer’s 5 features of student-centered practices ranging from 0 – 1. In the following list of learner-centered practices, I have inserted examples from other sources as noted:

- Balance of power between instructor and student; Focus is on both students and instructor; Students evaluate their own learning; instructor also evaluates;
Classroom is often noisy and busy, National Capitol Language Resource Center, www.nclrc.org; ]

- Use of content not to cover material but to develop skills of how to learn in the discipline and students’ awareness/confidence in their own learning; [emphasis is on generating better questions and learning from errors, Teacher-Centered Vs Learner-Centered Paradigms http://assessment.uconn.edu/docs/Teacher ]

- Instructor role as a facilitator or guide; [Students talk without constant instructor monitoring; instructor provides feedback/correction when questions arise; National Capitol Language Resource Center, www.nclrc.org;] [Students are actively involved; Professor and students learn together, Teacher-Centered Vs Learner-Centered Paradigms http://assessment.uconn.edu/docs/Teacher ]

- Climate where students primarily take responsibility for their own learning; [Students work in pairs, in groups, or alone depending on the purpose of the activity; Students answer each other’s questions, using instructor as an information resource; Students have some choice of topics; , National Capitol Language Resource Center, www.nclrc.org;] [Culture is cooperative, collaborative, and supportive, Teacher-Centered Vs Learner-Centered Paradigms http://assessment.uconn.edu/docs/Teacher ]; and

- Evaluation system that primarily promotes learning and self-reflection, rather than generating grades. [teaching and assessing are intertwined, assessment is used to promote and diagnose learning, Desired learning is assessed directly through papers, projects, performance, portfolios, and the like, Teacher-Centered Vs Learner-Centered Paradigms http://assessment.uconn.edu/docs/Teacher ]
On the other end of the continuum are teacher-centered practices. The following five characteristics outline teacher-centered practices:

- The teacher is the authority;
- The teacher determines content and organization of the course; emphasis is on acquisition of knowledge outside the content in which it will be used, emphasis is on right answers (Huba and Freed, 2000);
- Teacher is the model; only students are viewed as learners (Huba and Freed, 2000);
- Knowledge is transmitted from teacher to students; culture is competitive and individualistic (Huba and Freed, 2000); students are the recipients of the instructor's knowledge and expected to take responsibility for learning what the instructor tells them they must learn; students passively receive information (Huba & Freed, 2000);
- The teacher evaluates student learning; teacher is primary evaluator; teaching and assessment are separate; assessment is used to monitor learning; desired learning is assessed indirectly through the use of objectively scored tests (Huba & Freed, 2000).

Figure 3.4 below, displays the features of the learner-/teacher-centered continuum, along with the calibration to fuzzy sets (numbers ranging from 0 through 1) which were used to place teachers inquiry-based practices on the Y axis representing the continuum. To receive full membership (1) all five characteristics of learner-centeredness had to be present and no teacher-centered practices could be present; and to receive full non-
membership (0) all five characteristics of learner-centeredness had to be absent and all five teacher-centered characteristics had to be present (see discussion of teacher-centeredness in the literature review). The cross-over point (.50), the point that is neither fully learner-centered nor teacher-centered (full membership) nor fully absent of learner-centeredness and fully present of teacher-centeredness (full non-membership) consisted of equal characteristics of teacher-centeredness (TC) and learner-centeredness (LC).

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<th>Figure 3.4 Learner-Centered characteristics</th>
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<tr>
<td>Student Centered/ five characteristics</td>
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Reliability and Validity

Validity. Several types of validity pertain to this study: (a) Descriptive; (b) Interpretive; (c) Internal; (d) External; (e) Triangulation; (f) Peer debriefing; (g) Researcher reflexivity. Each is explored below.

Descriptive. Thick Description is a procedure for establishing credibility in a study through descriptions of the setting, the participants, and the themes of a qualitative study in rich detail. Rich details are a process of writing that provides as much detail as possible. “It may involve describing a small slice of interaction, experience, or action; locating individuals in specific situations; bringing a relationship or an interaction alive between two or more persons; or providing a detailed rendering of how people feel”
According to Denzin (1989), "thick descriptions are deep, dense, detailed accounts.... Thin descriptions, by contrast, lack detail, and simply report facts" (p. 83). The purpose of a thick description is that it creates for the readers the feeling that they have experienced, or could experience, the events being described in a study, creating credibility. Creswell and Miller (2001) state that, “rich description also enables readers to make decisions about the applicability of the findings to other settings or similar contexts” (p. 127 & 128).

The use of thick descriptions was constantly encouraged at weekly meetings and through reviews of observers’ written observations by other team members checking for dense detailed descriptions, and clarity (Denzin, 1989). Observers were instructed to use accurate descriptive words that created powerful pictures. Such as instead of writing that a teachers’ lesson was superb, that the lesson contained all five essential features of inquiry with descriptions of how that actually looked. Field note write-ups were also discussed at weekly meetings. The principal investigator used examples from observers’ write-ups to present exemplars and non-exemplars of powerful descriptions. Observers were expected to justify what they decided to record during their observations.

These descriptions were used in the process of validating how the teachers were placed on the inquiry-based and learner-centered continuums.

**Interpretive.** Observers used low inference descriptors such as direct quotes as frequently as possible. During the teacher interviews, teachers were asked for clarification of situations and their thinking. During weekly meetings, the principal investigators routinely questioned observers about their notes and the need to record as accurately as possible the actions and words of teachers and students.
Direct quotes of teachers’ verbalized thinking in the classroom during instruction as well as during their interviews were used in the process of placing teachers on the inquiry-based and learner-centered continuums.

*Internal.* Triangulation of data collection procedures included observations and interviews of the teachers. Observations make it possible to see the teachers’ behaviors, but it doesn’t tell us what is going on in their heads. However, the use of interviews and surveys revealed teachers’ thought processes and clues to their actions which aided in determining themes, categories and possible relational associations by providing better and stronger evidence.

Triangulation through the use of interviews and observation notes were used in the process of placing teachers on the inquiry-based and learner-centered continuums.

*External.* Generally speaking, this study should be able to generalize to other alternatively certified science teachers within this study’s identified configurations of teachers’ background experiences, programs’ characteristics, and school contextual factors. The sample of teachers was specific to make it possible to generalize to first year teachers from ATCP programs in science.

*Triangulation.* Triangulation is a validity procedure in which researchers search for convergence among multiple and different sources of information to form themes or categories in a study. The term comes from military navigation at sea where sailors triangulated among different distant points to determine their ship’s bearing (Jick, 1979). Denzin (1978) identified four types of triangulation: across data sources (i.e., participants), theories, methods (i.e., interview, observations, documents), and among different investigators.
As a validity procedure, triangulation is a systematic process of sorting through the data to find common themes or categories. A popular practice is for qualitative inquirers to provide corroborating evidence collected through multiple methods, such as observations, interviews, and documents to locate major and minor themes. The narrative account is valid because researchers go through this process and rely on multiple forms of evidence rather than a single incident or data point in the study (Cresswell & Miller, 2001, p. 126)

My study used observations, interviews, and artifacts collected during site visits and teacher observations (lesson plans, worksheets, school newspapers, program informational brochures, etc.). My study also used qualitative (comparative analysis, fuzzy-set qualitative comparative analysis) and quantitative (cluster analysis) analytic techniques to create continuums, configurations of cases, and clusters.

**Peer debriefing.** Lincoln and Guba (1985) describe peer review or debriefing as,

A review of the data and research process by someone who is familiar with the research or the phenomenon being explored. A peer reviewer provides support, plays devil's advocate, challenges the researchers' assumptions, pushes the researchers to the next step methodologically, and asks hard questions about methods and interpretations…. Peer debriefers can provide written feedback to researchers or simply serve as a sounding board for ideas. By seeking the assistance of peer debriefers, researchers add credibility to a study.
The parent study had the benefit of expert Science teacher educators and others who challenged assumptions and asked the hard questions about methods employed on the project and the interpretations being made. This study has the benefit that I was a part of the team and I attended meetings where these questions were asked and changes made. Plus, for my study, I have had the outside benefit of an inquiry expert to act as a debriefer. This debriefer validated my thinking and technique in the decision making process of placing teachers on the inquiry-based continuum.

**Researcher Reflexivity.** Moustakas (1994) presents researcher reflexivity as a validity procedure in which the researcher self-discloses assumptions, personal beliefs, values, and biases that shape their inquiry.

I was a graduate research assistant and a member of the team investigating the outcomes of alternative teacher certification in Missouri for science and math. I was involved in all phases of the project except for the preliminary studies and focus groups conducted by the lead investigators. I was specifically and personally involved in data collection, data storage and maintenance, some data analysis, and in presenting data findings at local, state, and national conferences over a 3.5 year period. I did observe, interview, and survey program directors, teachers, and instructors and helped create and maintain data files.

When I began this study, I did have a bias that favored alternative teacher certification, but I also wanted to research the outcomes of ATCPs because I am concerned about learners and the learning process. I wanted to be sure that ATCPs in the least could train teachers to enter the classroom prepared to meet diverse needs and to continue growing as teachers. I was also very interested in researching whether
alternatively certified teachers used available research on learners and learning and applied it successfully in their classrooms. I am aware that I have a bias towards ATCPs in general, but my experiences in the Teacher Development Program at the University of Missouri have acted as a balance in my thinking and have helped me become aware of the complexities of teaching, especially in the ability of beginning to teachers to understand and apply learning theory to the classroom situation.

To help control for this bias, I use negative case sampling (Burke, 1997). I included examples of exemplary science teaching as well as of non-exemplars of good science teaching as Burke (1997) suggests that researchers, “attempt carefully and purposively to search for examples that disconfirm their expectations and explanations about what they are studying” (p. 283). He further states that using this approach makes it difficult to ignore important information hence the results will be more credible and defensible.

**Instrument Reliability and Validity.** This study was, in one way, an exploration of possible methods from which to analyze a set of data that did not respond well to conventional statistical means of data analysis. The principal investigators ran correlations, t-tests, ANOVAs, and Regression analyses and found only one significant finding (discussed earlier) which lacked power due to the size of the data set. I created these scales as a way to help me look at the teachers’ performance using a different lens than had been used previously. I did not specifically test for reliability or validity. This would at this time, be the next step I would take given my findings.

I did discuss the inquiry scale with an inquiry expert, who did point out that some of the five essential features should be given more weight than the others, but the first
essential feature the most weight. The essential features I used on the inquiry scale were
derived by the National Research Council. These are used to determine what inquiry is.
Though it is intuitive that these could be used to form a scale, I do still need to validate
the scale and test for reliability.

I used Weimer’s essential features of learner-centeredness to actually determine
the properties of the Learner-Centered Scale and I used Huba and Freed’s work on
teacher-centeredness to help understand and to flesh out the learner-centered scale. This
scale also must still be validated and tested for reliability.

**Limitations**

The limitations of this study include the small number of alternatively certified
Science teachers which were eligible to be in the study – 42 the first year, 39 the second
year, and 33 the third year.

Zeichner and Cochran-Smith have documented the necessity of obtaining
administrator feedback on the performance of ATCP teachers in comparison to
traditionally certified teachers. This study did not collect such data. However, observers’
field notes should shed sufficient light on the teachers’ practices.

Cluster analysis and fuzzy set analysis are not totally accepted in the realm of
educational research, but have been slowly used and integrated into research found in
peer-reviewed journals. I have used triangulation of analyses to provide credibility for the
outcomes of the cluster analysis and have used validity procedures for the cluster analysis
which were explained in the literature review.
I also used validity procedures listed above for creating and placing the teachers on the continuums, but these will need further refinement and testing beyond the scope of this study.

CHAPTER 4
DISCUSSION AND CONCLUSIONS

As I move into the analysis and discussion sections of this study, I want to clearly state that even though many of the teachers in my study did not evidence strong inquiry-based practices or learner-centered orientations, it does not mean that they are bad teachers or that they did not prepare hands-on activities, nor create classrooms that students seemed to enjoy or care about the children in their classes. It does mean that many of them either did not or could not use inquiry and learner-centered approaches appropriately or effectively. Given the importance associated with inquiry, and the difficulty with which even traditionally trained teachers with more training class-time and more coursework have in learning how to use inquiry-based practices and to teach from a learner-centered orientation appropriately and effectively, whether or not alternatively certified teachers are able to use inquiry and sufficiently develop learner-centered orientations is important.

This chapter will move through several phases each with its own synthesis and summary, culminating in a final summary. The phases correspond to the steps outlined for answering each question.
Question One

Step One and Step Two: Inquiry-based Practices and Learner-Centered Continuums.

Inquiry-Based Continuum. The inquiry-based practices continuum was created through a qualitative analysis of the National Research Council’s and the National Science Teachers Association’s literature on inquiry-based practices as well as articles written by educational researchers (such as Abel, 2005) on inquiry-based practices. In reviewing articles on inquiry, I found that the NRC’s five essential features of inquiry could be used to develop and structure a continuum for inquiry-based practices. Though previously discussed, I include the five essential features of inquiry here: 1. Learner engages in scientifically oriented questions; 2. Learner gives priority to evidence in responding to questions; 3. Learner formulates explanations from evidence; 4. Learner connects explanations to scientific knowledge; 5. Learner communicates and justifies explanations.

Calibrating/Deriving the location of individual teachers and clusters of teachers on the continuum was managed through fuzzy set qualitative comparison principles on assigning quantitative measures to qualitative data. Specifically relevant literature on inquiry-based and learner-centered instruction provided information on full inquiry and learner- and teacher-centered practices. Individual teachers’ practices, teachers’ grouped by their level of practices and by their ATC programs were then separately analyzed according to the continuum and placed accordingly. Hence the continuum was used to analyze individual teachers’ inquiry-based practices, individual clusters of teachers’ inquiry-based practices, and overall alternative teacher certification programs’ teachers’
practices. These findings were used later in the overall analysis, but are displayed below and initially discussed in their own merit. But, first I discuss the continuum’s levels.

Below, Figure 4.1, is a definition for each of the levels as delineated by the National Science Foundation (2000).

| Figure 4.1 Essential Features of Inquiry with Fuzzy-Set Calibration |
|-------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 0                      | 0.13            | 0.25            | 0.37            | 0.5             | 0.63            | 0.75            | 0.88            | 1               |
| Fully Out / missing    | Mostly, But Not | More Out        | More Or Less Out| Neither In Nor  | More In Than    | Mostly But Not  | Fully In        | None of the     | None of the     |
| all features           | Fully Out       | Than In         | Out / missing   | Out / missing   | Than Out /      | Fully Out       | In / None       | Essential       | Essential       |
|                        | Question        | missing question| Question and 2  | missing Question| question and 3  | Question        | Question        | Features are    | Features are    |
|                        | and 3 other     | other features  | other features  | and 1 other     | features, but   | but not question| but not question| missing         | missing         |
|                        | features        |                 |                 | feature         | question        |                 |                 |                 |                 |

Though explained previously in this paper, I reiterate here for ease of understanding. The following lists the essential features of inquiry used in Table 6 above.

- Learner engages in scientifically oriented questions/problem;
- Learner gives priority to evidence in responding to questions;
- Learner formulates explanations from evidence;
- Learner connects explanations to scientific knowledge;
- Learner communicates and justifies explanations.

Initially, I gave the five essential features equal status and placement ratings were quantified from 0 to 1 with .05 as the midpoint. But, after discussions with an inquiry expert I decided to give the question/problem essential feature more weight. For a teacher’s practice to cross-over the mid-point or crossover point towards full inquiry that
teacher had to have the question/problem feature evident in their practice. Without the question/problem feature the practice the midpoint or crossover point towards fully out of inquiry. The rating levels and their characteristics are outlined below:

- **1.00 / Fully In**: All five of the essential features are present, but they can and do vary in student-centeredness levels.

- **.88 / Mostly But Not Fully In**: Must include essential feature 1, learner engages in scientifically oriented questions and may contain any three of the other four to receive a value of .88.

- **.75 / More In Than Out**: Must include essential feature 1, and any other two of the essential features to receive a rating of .75.

- **.63 / More Or Less In**: Must include essential feature 1, and any other one of the essential features.

- **.50 / Neither In Nor Out**: Missing all features except feature 1

- **.38 / More Or Less Out**: Feature 1 is missing and 3 other features are present.

- **.25 / More Out Than In**: Feature 1 is missing and two other features are present.

- **.13 / Mostly Out But Not Fully Out**: Feature 1 is missing and one other feature is present.

- **0.00 / Fully Out/ Absence of inquiry**: None of the five essential features of inquiry are present.

The inquiry-based practices continuum, Figure 4.2, reveals that the majority of teachers hovered around the absence of inquiry, 0, and then scattered throughout the continuum reaching beyond the cross-over point to .88. All teachers over the mid-point
displayed the first essential feature – learner engages in scientifically oriented questions – and one or more of the other features. None of the teachers were rated fully-in, a score of 1, as shown below. Figure 4.2 depicts teachers’ inquiry, but leaves out another essential element, learner-centeredness, for inquiry teaching to find its fullest expression.

**Learner-Centered Practices Continuum.** As defined by Weimer (2002), learner-centered teaching is associated with the following five characteristics:

- A balance of power between instructor and student; Focus is on both students and instructor; Students evaluate their own learning; instructor also evaluates; Classroom is often noisy and busy, (National Capitol Language Resource Center, 2010);
- The use of content not to cover material but to develop skills of how to learn in the discipline and students’ awareness/confidence in their own learning; emphasis is on generating better questions and learning from errors (Huba and Freed, 2000).
- An instructor role as a facilitator or guide; Students talk without constant instructor monitoring; instructor provides feedback/correction when questions arise (National Capitol Language Resource Center, 2010); Students are actively involved; Professor and students learn together (Huba and Freed, 2000);
- A climate where students primarily take responsibility for their own learning; Students work in pairs, in groups, or alone depending on the purpose of the
activity; Students answer each other’s questions, using instructor as an information resource; Students have some choice of topics (National Capitol Language Resource Center, 2010); Culture is cooperative, collaborative, and supportive (Huba and Freed, 2000).

- An evaluation system that primarily promotes learning and self-reflection, rather than generating grades; teaching and assessing are intertwined, assessment is used to promote and diagnose learning, desired learning is assessed directly through papers, projects, performance, portfolios, and the like (Huba and Freed, 2000).

On the other end of the continuum are teacher-centered practices. The following five characteristics outline teacher-centered practices according to Huba and Freed (2000):

- The teacher is the authority;
- The teacher determines content and organization of the course; emphasis is on acquisition of knowledge outside the content in which it will be used, emphasis is on right answers;
- Teacher is the model; only students are viewed as learners (Huba and Freed, 2000);
- Knowledge is transmitted from teacher to students; culture is competitive and individualistic (Huba and Freed, 2000); students are the recipients of the instructor's knowledge and expected to take responsibility for learning what the instructor tells them they must learn; students passively receive information (Huba & Freed, 2000);
- The teacher evaluates student learning; teacher is primary evaluator; teaching and assessment are separate; assessment is used to monitor learning; desired learning is assessed indirectly through the use of objectively scored tests (Huba & Freed, 2000).

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<th>Figure 4.3 Learner-Centered Characteristics</th>
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<td>Teacher Centered/No SC characteristics</td>
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<td>Mostly Out/one SC Characteristic</td>
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Interviews and write-ups from field notes were used to place teachers on the learner/teacher-centered continuum. The learner-centered continuum displays teachers’ learner-centered practices rangeing from 0 to .8. It reveals four groups and one outlier.

The teacher groupings on their one dimensional axes tend to lump teachers together, but introducing another dimension by combining the two continuums creates another more holistic picture of these teachers (Figure 4). Teachers’ scores from the inquiry-based and learner-centered continuums are combined to form ordinates on the X
and Y axes of the continuum plane. Inquiry-based practices lie on the X axis and learner-centered practices lie on the Y axis. This gives us a very different picture of these teachers and their similarities to one another and leads to Step Three.

**Step Three: Combined Inquiry-Based and Learner-Centered Continuums.** A careful examination of the plotted points revealed two groups, one group curving around the other. The curving group was spread throughout quadrant 1, 2, and 4. The second group was more tightly grouped in quadrant three. The teachers in quadrants 1, 2, and 4 can be thought of as non-traditional as they evidence practices not associated with traditional instructional practices. The non-traditional groups in quadrants 1, 2, and 4, at first glance, appear to be a scattered group throughout those quadrants. But a closer inspection reveals a configuration of two groups with one group in quadrant 2 consisting of one teacher and the other group shaped somewhat like an hour glass spread across quadrants 1 and 4. The group of teachers in quadrant 1 and 4 I have termed the One-Sided Group. This group displays elements of either inquiry or learner-centeredness, but not both. The other group in quadrant 2, I have termed Decided. The teacher in this group displayed features of both inquiry and learner-centeredness. Within the Traditional group, in quadrant 3, the teachers are arranged in several groups. Two of the groups have the majority of the teachers and the third group consists of three teachers spread out in a straight line moving towards the inquiry midpoint.
Step Four: Discussion of Teacher Groups and Overall Program Levels. The majority of the teachers fell into the traditional group (See Figure 5, below). It is important here to distinguish that some of these teachers were beginning to incorporate inquiry-based and learner-centered practices, but not enough elements were present, nor did the study follow them long enough to know if their practice grew enough to place them in the non-traditional group. In the growth analysis, later in this chapter, I do discuss this more. However, here I will note that teachers TXI6, TXI11, TFO26 showed steep positive trends towards inquiry. A few of the others showed very slight positive
trends and in light of the literature on teacher growth, these teachers would not be expected to improve significantly over the next 5 years which is the cut-off for most teachers’ growth in terms of student outcomes.

Only one teacher scored in the Nontraditional Decided quadrant, Heather (Teacher TFO22). Heather also evidenced significant growth over time as shown in the Teacher’s Growth (p. 112) section of this paper. Seven teachers were in the Nontraditional quadrants 2 and 4. Three of the seven were in Quadrant 2 (TXI4, TXI12, and TJQ33), and four were in Quadrant 4 (TXH1, TXH2, TXH3, and TKD17). It is disappointing that only 24% of the teachers in this study were in the Nontraditional Quadrants. These quadrants represented inquiry-based and learner-centered orientations. It seems apparent from this continuum plane that the ATCPs were not able to prepare the teachers adequately for entry level inquiry-based instruction or learner-centered practices. This then leads into a discussion about the programs themselves.
Program aggregate scores. Figure 6, below, displays the programs aggregate inquiry and learner-centered scores. It provides another perspective from which to view program outcomes. Six of the program’s aggregate scores fall squarely in the Traditional Quadrant. Program 8 is borderline into Quadrant 1, low inquiry and high learner-centered. Program 1 aggregate scores were in Quadrant 4, high inquiry and low learner-centered. Program 6 aggregate scores were in Quadrant 3 completely obscuring that the sole teacher in Quadrant 2 came from Program 6. Program 3 had one teacher in Quadrant 1, which is obscured by the low scores of the rest of the teachers in Program 3.
The continuums and the table above tell us “what is” as a number, but do not tell us what happened, what the teachers actually did and how they attempted to incorporate what they thought were inquiry-based and learner-centered practices. That is discussed later in this chapter. The next section discusses the programs themselves.
In general, programs had many similar as well as different features. Table 4 below compares components of the 8 programs in the study. The components can be broken into specific areas identified earlier as important aspects of alternative certification programs. Three of the components have to do with entry and exit standards: GPA, the interview process, and exit requirements. GPA’s across the programs ranged from 2 (probationary status) to 2.75 and four programs had a rigorous screening process and two others had a screening process that was not rigorous, 1 program did not have an interview process, and there was no data on one program. Seven programs required a portfolio (Program 3 did not have data indicating their exit standards). Of the seven programs, four also required an action research project. Next in Table 4 is general pedagogical training. Six programs specifically focused on pedagogy through coursework and two did not. Four programs sequenced their coursework. One program was partially sequenced, and three programs were not sequenced. Important in learning to use inquiry and learner-centered practices is whether or not the instructor models these and makes their thinking transparent. Two programs did not have data on practices such as modeling. One program that utilized adjuncts had an instructor that did model learner-centered practices and another that did not. Project observers did not note any inquiry practices of any of the science methods instructors except for one program. Only one program specifically taught and modeled inquiry. One program had methods courses with mixed content (i.e., methods of history, art, math, science in one class) and the others had specific science methods courses in which inquiry was a section studied.

Five programs had individualized programs tailored to deficits in teachers’ training and knowledge. One program was only individualized for teachers who lacked
content requirements. Two programs were not individualized. All programs with teachers in the classroom as the teacher of record used those teachers’ on-the-job experiences as part of their field requirement. One program provided student teaching for individuals that had either not found a teaching position or that desired more time in a supervised experience.

Data did not include consistency information on all of the programs, but it is important to note that on two occasions two separate programs had faculty that either taught incorrect content or blatantly taught teachers traditional viewpoints on classroom management and pedagogy in direct opposition to the program’s espoused learner-centered position.
Program 1. Program 1 aggregate scores from the inquiry-based and learner-centered continuums were: Inquiry, 1.60 and learner-Centered, -.048. Interviews of the teachers demonstrated program consistency. This program had the median GPA requirement of 2.5, had a substantive interview process, required a portfolio as part of exit requirements, but advertised that there was no culminating comprehensive exam. Courses were sequenced, but the program was partially individualized to provide training in deficit areas. This program also provided mentoring and supervision of teachers. However, Program One did not have any courses dedicated to inquiry or science methods, courses focused more on general methodology and learning theories in general.

Teacher TXH2, whom I will call Emma, rated high in inquiry (.88), over the cross-over point towards full membership in inquiry-based practices. However, she rated low on learner-centeredness (.4), over the cross-over point towards absence of learner-centeredness. Some educators would see this as a contradiction, believing that inquiry-based instruction cannot be practiced without a corresponding learner-centered orientation. However, when looking strictly at the NSF’s 5 essential features of Inquiry as standard 1, learner-centeredness is not mentioned. In observing and interviewing this teacher, it was evident that she wanted to be more learner-centered as well as more inquiry oriented. She mentioned, “I would like to be more inquiry-oriented, but I don’t know how,” a sentiment echoed by the other inquiry-oriented teacher in this program. Even so, these teachers were in the Nontraditional One-Sided group exhibiting the beginnings of inquiry-based practices without a corresponding learner-centered orientation, without explicit instruction and modeling from program instructions.
Emma demonstrated inquiry-oriented thinking in her interview when she spoke about her use of labs,

I think I would say that the lab, they always learn most from labs. I mean, demonstrations are nice, and there are some things that with freshman I will only do as demonstrations, and they do learn from them, but I think that when they actually have to sit there and every single student has to think about it, it’s much more effective.

Later in her interview she mentioned a lab the students had completed previously and indicated that students were expected to justify what they did based on the physics they had learned about friction,

The larger unit, at the culmination of this whole unit, we did a two week lab of designing a bobsled. They had to design a bobsled and then we had races. I mean the race part, I mean that was fun, they had to justify why they designed it. They were trying to minimize friction and that sort of thing, and then they actually had to write a lab, like an “I predict” kind of hypothesis, a whole full-fledged lab and do a type written lab report. And they had to carry out the lab too…

Though Emma had the students perform a lab using a step-by-step approach akin to “cookbook labs” she created the lab and it definitely went beyond a “cookbook lab”. The lab was a partial and guided inquiry – guided by the worksheet. Emma’s worksheet asked a scientifically oriented question, led the students to gather data to answer that question. She provided the students with a data table that was a scaffold to help them
gather the data. The lab prompted the students to analyze the data and to develop evidenced-based explanations using two questions at the end of the lab. Students were given an opportunity to justify their explanations in the two concluding questions.

Emma also displayed teacher-centeredness in her interview when discussing misconceptions (I need to note, that few of the teachers in my study assessed for misconceptions and the majority when asked, spoke about difficulties with the lesson plan rather than student misconceptions), she lamented, “They just don’t follow directions worth a darn. I mean, they don’t. And we’ve [the other science teachers at her school location] talked about how it’s gotten worse. In the three years I’ve been here, I used to be able to give them a brief outline and they could read it. I mean, I would write everything out and they can’t do that anymore, or they won’t. I don’t know which one it is, we don’t know.” Emma admits to knowing that the students were not capable or were perhaps unwilling to follow her directions to work without her direct input, but continues to practice in the same manner that previously worked for her stating, “I can’t figure it out other than…there’s something beyond school because all of us in the science department believe that they can all do well. And come with the expectation that they will. And then I’m always surprised, I’m like, why can a bright kid, why do they not try? And it’s sadly the way it is”.

With a more learner-centered approach and strong scaffolding during the first few months of school, Emma probably could have trained her students to become more responsible for their own learning. In one conversation with Emma, she revealed her idea of “students taking responsibility for their own learning”, which consisted of simply requiring that students take more responsibility rather than letting go of her strong
teacher-centered control and giving the students some choices and scaffolding them into greater responsibility, not by demand, but by balancing the power within the classroom.

Teacher TXH3, whom I will call Lela, on the other hand, tottered between balancing teacher control versus student control. She was also, like Emma, more inquiry-oriented than learner-centered. She did prepare labs that asked questions and expected her students to derive hypothesis and create experiments to answer the questions, but her framework for doing so was so tight that students had little room to begin taking responsibility for their own learning. In one lab observed with Lela, students were presented with a question, “Who can throw a football the farthest, males or females?” Lela had two objectives with this lab/experiment: 1. application of the metric system of measurement; and 2. writing a hypothesis. Lela wanted to allow her students to experience inquiry, but she had not had any formal training and consequently did not understand how to lead her students towards a more powerful inquiry. She did not carefully pick her question in light of what she wanted her students to know and do and align it with the science content she was covering at the time.

Lela’s attempt at learner-centeredness was based on her conception of what might be fun for the kids to do, a common problem among the teachers in this study. Part of learner-centeredness and inquiry-based instruction is giving students more voice in decisions. When teachers do that, they may find that their students have entirely different interests and motivation then the teachers had thought. In this instance, Lela developed a lab/experiment plan that was competitive and caused some of the students to experience humiliation for not being able to throw farther than the girls and the girls who could
throw a football further than some of the boys were ridiculed as being manlike, “Jesus Christ! She’s a man!”

Lela should have brainstormed with her students, allowed them to work in groups to identify an area of interest within her curriculum and helped them to develop their own labs/experiments. She was on the right track, but with mentors that were not well versed in inquiry, she did not have the type of assistance she needed to develop beyond actually supplying a question (in this case, one that lacked substance) and one of the other essential features, specifically: learner gives priority to evidence in responding to questions. In this instance, students collected data from two throws of the football by each student. In a very rudimentary manner, Lela did address another feature (feature 3, learner formulates explanations from evidence), but not enough to have received the next higher score on the scale. While Lela did have the students answer the question using their collected data, the question was posed in such a way that the students really did not need to formulate an explanation from the data. Lela’s lesson had potential, but she lacked a complete understanding of inquiry and of how to create substantive questions as described earlier in this paper (see Inquiry Questions, p. 22).

Another difficulty that Lela encountered was balancing the power in the classroom. She controlled every facet of the lab from beginning to end. She instructed how to line up, how to proceed once outside, her voice could be heard the entire lab directing and encouraging the students to follow the outline she had provided for them. She attempting to do the lab as a whole class lab that slowly deteriorated into groups of students that were off-task, some sitting and chatting, some throwing an extra football back and forth and interfering with those still engaged in the lab, and some students
aimlessly wandering around. To be more learner-centered, Lela should have given the students some responsibility to plan the how to of the lab. For instance, students could have brainstormed the necessary steps to the lab and decide how to divide the lab work-wise among all the students. Each group could then have spent some time planning how they would do their assigned task. Given the nature of this lab, Lela would have had to plan the overall lab thinking about how to involve all the students either with the lab or with some other part of the lab after students completed their specific task. Or Lela could have divided them in groups to perform the lab with some of the students working on some other task, while other students performed the lab.

Lela also needed to learn how to facilitate appropriately. She controlled every aspect of the lab and was so busy yelling instructions that she missed errors that the students committed in performing the lab as well as the taunting in which some of the boys engaged towards less athletic males and more athletic females.

It was apparent that Lela wanted to involve her students more, in her interview she stated that her program did not teach much about inquiry and that she wanted to do more with it. Her teacher-centered orientation was interfering with her ability to involve her students more in the labs.

To summarize, program One required a 2.5 GPA and had an extensive interview process; required a portfolio, included pedagogy, and science methods courses, was individualized, was sequenced, and consistent. The teachers in Program One were strong in their content, through prior coursework and/or career experiences. All three teachers in the program found one of the program’s elements especially useful to them when
teaching on their own – the opportunity to have observed classes in action as part of their program which included an entire course held within a school context.

Program two. Program 2 aggregate scores from the Inquiry and Learner-Centered Continuums were: Inquiry, .1 and Student-Centered, .8. Program 2 required a 2.5 GPA and did not require an interview. It did require a portfolio to be turned in at the end of the program. The program was not consistent throughout, a function of an adjunct faculty that did not support the learner-centered message of the program. In one class observed the instructor stated that he did not believe in being learner-centered, but he would teach the class about that viewpoint and then he would tell them what really worked with the kids at his school. On the other hand, this program had another instructor that not only taught learner-centeredness as part of a reading across the curriculum course, but modeled it, and made his thinking transparent as well. Teachers in this class were not left guessing what instructional methods he was using or why. They worked on using these methods in their classrooms and reported back the next class-time. This program did not provide an inquiry course, but did provide a specific science methods course. This program was also individualized for deficits in content and was not sequenced. Teachers’ individual inquiry ratings ranged from 0 through .38 and leaner-centered ratings ranged from 0 through .63. One teacher passed the cross-over point into learner-centeredness, but none passed the cross-over point towards inquiry-based instruction. Almost all the teachers at one time or another in a lesson used a feature or two of inquiry-based instruction and/or learner-centeredness, but it was not consistent enough or substantive enough to warrant a higher score than they received.
The highest inquiry score went to one teacher, Michelle (Teacher TXI9). Michelle had developed an outdoor classroom and created a year-long project question to her students. They were to investigate the growth of fish over the year in the pond that was a part of their outdoor classroom. They caught and tagged fish with the date, and they captured and placed fish in several aquariums in their classroom. The fish in the aquariums received different amounts of food. These fish were compared for growth over the year and then compared with the fish in the pond to explain the size of tagged fish in the pond at the end of the year. They also used data collected the previous year on fish size. The students were expected to tie this together with information they learned on food webs. The students were engaged throughout the year with observing conditions at the pond and understanding relationships between predators and prey, producers and consumers, as well as levels of consumers. The task was authentic and involved much planning on the part of the teacher (there is an overlap of inquiry and learner-centeredness).

Michelle, was not especially concerned about inquiry, but her lesson included a question and the collection of data, as well as the expectation to derive explanations from the data. I did not rate Michelle any higher on inquiry than a .625 because she did not allow the students to derive the explanation. Michelle liked to talk, was enthusiastic, but often told the students what she stated she wanted them to investigate. If Michelle had been more inquiry oriented in her thinking, she could have had a powerful learning tool in the outdoor classroom.

Michelle did not do as well with student-centeredness as she did with inquiry. Even though it was evident that she was attempting to balance power in the classroom, by
giving the students choices in how to perform their tasks, she retained power through knowledge. She did not always share her expectations or class plan for the day with her students, but would hold them accountable for those expectations and for the plan. For instance, in one class Michelle was preparing some materials for the outdoor classroom, but didn’t have enough time before the students arrived for class. Instead of explaining what they were going to do and with which tasks she might have needed assistance, she quietly worked on completing her tasks until the noise level in the class became too loud and she announced, “Everybody ready to go? I will know that everybody is ready to go when it is quiet.” The class chatter died, and the teacher continued with what she was doing with no explanation to the students. In a few minutes the students began to chat among themselves again. Finally Michelle reiterated, “You are wasting my time.” It was obvious Michelle was not ready to go and that the students were not wasting her time, but she was wasting their class time. A few minutes later Michelle stated, “still waiting, everybody in their group?” When Michelle finished her preparations she finally instructed the students to head out to the outdoor classroom.

While Michelle obviously had to learn how to consistently balance power in her classroom, she gave the students much freedom in completing tasks in the outdoor classroom. Once in the outdoor classroom Michelle took on a more facilitative role, encouraging students to complete their tasks, visiting groups and asking and answering questions. Michelle did not rate any higher on learner-centeredness because though she used groups and the kids did obviously enjoy the outdoor classroom, Michelle created the groups without much input from the students on how groups would be created or what
tasks needed to be completed and her actions in the indoor classroom were too teacher-centered and power oriented.

One area on which Michelle excelled was in the use of content to teach skills and how to learn in the discipline. Michelle was on the verge of creating a climate where students took true responsibility for their own learning, but she could not relinquish enough control for the students to experience taking responsibility for their own learning. Michelle was also on the verge of evaluating to promote learning and self-reflection.

Michelle’s students kept journals and did many activities that could have promoted learning and self-reflection, but in watching the students present projects on which they had worked for several weeks, very little learning occurred as well as little reflection. The students relied too heavily on Michelle for their learning and when Michelle did not provide scaffolding to help move her students into learning and self-reflection, her students floundered. The projects presented by the students during this observation were done by groups. However, it was very evident that no real collaboration had occurred. Students presented their part of a group project without any reference to the work of the other students in that group. None of the students were able to talk about their part of the group project without frequent prompting by Michelle, or else they simply read from a sheet of paper about their project. Michelle was attempting to be learner-centered and to get her students to take responsibility for their learning, but like other teachers in this study, she failed to understand that she had to provide scaffolding and to teach the students how to take responsibility.

Another teacher in this group, TX112, whom I will call Dan had the highest learner-centered score even though he had difficulty balancing power in the classroom,
used content to develop skills of how to learn in the discipline and to heighten students’ awareness of their own learning. He took the role of facilitator and guide when the students worked in groups or individually on projects/labs/experiments.

Dan’s class was quite hands-on and included many activities to help the students understand the physics concepts that he taught. He tried to include projects that he thought his students would like and feel motivated to complete. Students were expected to take responsibility for their own learning and Dan helped provide scaffolding and background content so students could take that responsibility. Dan had not yet developed an evaluation system that primarily promoted learning and self-reflection, for example:

At one observation Dan had a student that was not measuring the dimensions of a sheet of aluminum foil properly for a physics lab and when the dimensions were inadequate for the lab purposes, the student was not given an opportunity to cut the foil again. No opportunity to reflect, no opportunity to reinforce the skills, the student was left to finish the lab knowing that the outcome would be a failure. Dan needed to learn to give students some room to make mistakes and to go back and try again.

To summarize, program two required a 2.5 GPA, no entrance interview, and a portfolio as part of its exit requirement. While there was no evidence that Program Two instructors modeled inquiry, there was evidence that at least one instructor modeled a learner-centered orientation. Program Two provided pedagogy and science methods courses that were not specifically inquiry-based. The Program was individualized, but was not sequenced. Out of ten teachers, 9 did not evidence essential feature 1 of the five essential features.
**Program three.** Program Three’s aggregate scores from the inquiry and learner-centered continuums were: Inquiry, .22 and Student-Centeredness, .25. Inquiry ratings ranged from 0 to .88 and Student-Centeredness ranged from 0 to .4. Data was sparse on this program, but it did require an entry GPA of 2.5 and there was no other entry or exit requirement noted in the study’s data. The program was partially sequenced and partially individualized, did not have any courses on inquiry, and did not explicitly teach pedagogy. All of the teachers in this program left by the third year. One of the teachers’ inquiry-rating was one of the highest of all the programs.

This teacher, whom I will call Mike (TKD17), began his observed physics class on projectiles and motion along a curve with this question for his students, “If you shoot a bullet straight out and dropped another one straight down, which one hits the ground first?” He allowed the students to discuss and to make their thinking and understandings clear. From the question he moved into a mini-lecture and a teacher demonstration using an apparatus that shot out a ball and dropped another simultaneously. The students had an opportunity to collect data by watching and recording what happened. Then Mike had them perform their own lab to collect data as groups. Though this lesson scored one of the highest inquiry scores, it still lacked in some ways.

Mike began with a question that was not intuitive to answer and would motivate students to discussion and to collect data. Students, posed answers according to their experiences and about half of the class demonstrated misconceptions thinking that the bullet dropped to the ground would hit the ground faster than the one shot straight out. At that point, instead of the demonstration and lecture he should have allowed the students to discuss how and what data to collect to answer this question. Then, the students could
have once again discussed the question in light of the collected data. At that point, Mike
could have presented his mini-lecture on projectiles and motion along a curve and
completed his demonstration. From there, he could have prompted the students to connect
their observations and explanations to the theories Mike wanted his students to learn. He
should have gone one step further and had the students communicate their findings and
justify their previous explanations using theory and data. Though interesting and well-
prepared for classes, Mike was not very learner-centered. He did use groups, and he did
seem to aim for understanding, but he was definitely the power in the classroom. Mike
did not really use content to help the students learn about their own learning, he used it
more to cover material, which was reflected in the one-day allotted to answering his
posed question. He partially played the role of facilitator with the opening discussion, but
did not go far enough in guiding the students towards a way to answer the question,
instead he allowed them to grapple with the question for a while and then gave them the
answer.

Mike’s instructional style did move towards creating a learning environment
where students could begin to take responsibility for their own learning. He provided
scaffolding to allow the students to answer questions, seek answers in their text book, and
to perform a lab as groups of two. He also used informal assessment as a way to gauge
students’ understandings. The entire lesson was geared towards student learning and self-
reflection as demonstrated by Mike’s introduction allowing students to discuss and reflect
as he moved them through the phases of his lesson plan.

Program four. Program Four’s aggregate scores were: inquiry 0 and learner-
centeredness 0. Entry requirements for this program were a 2.0 GPA and an entry
interview that was not rigorous. The exit requirement of this program was a portfolio. The program was individualized and geared towards individuals with teaching contracts and no credentials. The program had a science methods course, but did not teach inquiry, nor did program instructors model inquiry or learner-centeredness.

There was only one teacher in this program, MSV18, whom I will call Maggie. Maggie lectured and wrote notes on the board at the same time. Students spent most of their class-time copying notes as the teacher lectured. The teachers’ questions were aimed for memorization of facts, but on more than one occasion she did attempt to draw her students into discussions on global warming, etc. The observer noted, “There was minimal student participation. The teacher lectured and the students took notes, answered the teacher’s questions, and a few times asked clarification questions about the differences between meiosis and mitosis.” No activities were done with this lecture.

Two other teachers in this study who were also teaching genetics units when observed had planned activities that in the least helped students grasp the concepts. One teacher had the students play-act that they were chromotids in the act of crossing over. The entire class took part in the demonstration and the students who had voiced confusion beforehand were able to verbalize the procedure afterwards. That demonstration took less than five minutes of instructional time. The other teacher in this study had prepared a demonstration, not as well planned as the preceding, but the students were amino acids creating a protein. These types of demonstrations seemed to help students’ grasp of the material. However, Maggie didn’t seem to have any concern about inquiry or learner-centeredness. She voiced no concern that her class might be boring or that she could provide greater opportunities for students’ learning.
Program five. Program Five’s aggregate ratings on the inquiry and learner-centered continuums were: Inquiry, 0 and Student-centeredness, .1. Neither of the teachers in this group displayed inquiry or student-centered orientations, though at times they did display a feature or two of inquiry or student-centeredness. This program required a GPA of 2.0 and an entrance interview, and action research was required to be completed at the end of the program. Courses included pedagogy, science methods, and were sequenced. Instructors did model some learner-centeredness, but the program lacked consistency.

Program six. Program 6 aggregate scores were in Quadrant 3, but one teacher, TFO22 was in Quadrant 2. Teachers in this group made an effort to use inquiry as noted in many of their interviews. This program required a 2.75 GPA, a telephone and recorded teacher interview questionnaire, required both a research action project and a portfolio, demonstrated consistency, provided pedagogical as well as science methods courses, consistent inquiry and learner-centered orientation throughout, was not individualized, and had a field component for those teachers desiring more experience in the classroom before becoming the teacher of record. Teachers from this program leaned toward learner-centeredness, but not enough to pass the cross-over point towards learner-centeredness. They asked questions, used groups, and prepared hands-on activities, but did not know how to engage students in a substantive question that would move their students’ investigations through the rest of the inquiry essential features.

Program seven. Program 7 aggregate scores for program seven were also in quadrant three. Inquiry scores were 0 and learner-centered scores were .2. Program 7 had a 2.75 entry requirement, but did admit students with a 2.5 on a probationary status, so
essentially had a 2.5 GPA requirement. The program required a portfolio as part of its exit requirements. While low on inquiry-based practices, this program did demonstrate a learner-centered orientation with some of its instructors. However, this program went through 3 distinct reorganizations between 2004 and 2007, meaning that consistency was a problem.

The one teacher in this program that fit study requirements voiced care and concern for the students, but that was not translated into a learner-centered orientation, “It’s a chance for them to do something hands on, you know, and we’ve done a number of different things like that, models involving other things, balloons and other types of materials involving…sand and water and using dies and alcohol mixing and so on”. What this teacher was missing was an understanding of inquiry-based instruction and learner-centeredness. He tried to motivate the students with what he thought were interesting hands-on activities, but without first ascertaining whether or not the activities would be interesting, motivating, or important to these students. Hands-on activities are neither automatically inquiry-based or learner-centered. Hands-on activities used appropriately and effectively are a tool of inquiry-based practices and of learner-centered orientations. This teacher and other teachers in this study did seem to commit that error, mistaking hands-on activities as inquiry and/or learner-centeredness.

*Program eight*. Program 8 aggregate scores placed teachers from this program low on inquiry, but just crossing over into student-centered orientations. Aggregated inquiry scores were 0 and aggregated learner-centered scores were .5. Program 8 required a 2.5 entry GPA and also required an exit research project and portfolio. This program was sequenced, lacked consistency, and while not including inquiry as a theme
throughout, it was included as a part of its science methods course. The ineffectiveness of providing inquiry instruction as part of a science methods course was recorded in a statement by one its graduates when asked about inquiry-based instruction, “There wasn’t a lot of that in the career transitions program that I’m in, but through professional development through the district and becoming involved in the Science Center that I’m in and the workshops offered through the district and the Science Center have really been helpful”. However, in spite of professional development, this teacher did not demonstrate inquiry and like the teacher in the previous program, she did hands-on projects, which are not necessarily inquiry-based. She also demonstrated a high level of learner-centeredness, but did not evidence inquiry-based practices.

**Summary.** Programs at first may not appear to play a significant role in teachers’ instructional practices. But, in looking closely at the continuums and comparing program components among low performing programs certain elements are absent in the lower performing programs: dedicated inquiry courses and consistent inquiry throughout and modeling of inquiry and learner-centeredness by program instructors. It is clear that about half of the higher performing programs also lacked the very same components leading to the conclusion that the lack or presence of these components may be sufficient, but not always necessary to an outcome of absence of teacher-centered practices and of inquiry, and that depending on other variables presence or absence, programs may play a role in when and how teachers’ use and experience growth in inquiry and learner-centered practices.

The four lowest scoring programs had some similar characteristics: they required a portfolio, but did not require an action research project. None of these programs
specifically taught inquiry, however they did have a dedicated science methods course. The observed instructors in these programs did not model inquiry-based or learner-centered practices, except for one. None of the other components studied within the programs were common to all of the low performing programs, leading to another possible conclusion that the common components must exist in conjunction with components in other variables studied, such as: teacher and school variables or specific characteristics within a variable. This is considered in light of the fact that none of the programs’ graduates did all that well on either the inquiry continuum or the learner-centered continuum.

The program aggregate scores imply that one variable alone does not exert enough influence by itself, that it is probably sufficient depending on the teachers’ school context or teachers’ characteristics before entering the program, but that it is not necessary for the outcome of low inquiry and low student-centeredness except when present with other variables it may be sufficient or even necessary. This alludes to the possibility that the relationships among the variables of interest are not linear, but are configurations that can be associated with certain outcomes.

In looking at school context, of the 18 traditional teachers, only 2 were not in high poverty schools, so combining high poverty with a program lacking explicit instruction in inquiry and low instructor modeling of inquiry and learner-centered practices may be sufficient for low inquiry-based practices and learner-centered orientations of the teachers in this group. At the same time, three programs in the traditional group had no teachers in the non-traditional group. The other four programs had teachers in both the traditional and non-traditional group.
Question Two

Teachers’ Practices over Time.

**Program 1.** Two teachers in program one showed marked increases in inquiry-based practices over time. One teacher remained flat over the three years of the study. Two of the teachers only taught for two years, one of them, TXH2, left classroom teaching in her second year to become a science teaching coach and the other, TXH3 did not have a teaching position in the first year of the study. Teacher TXH2 evidenced a higher level of inquiry teaching and a steeper growth trend than the other two teachers (See Figure 4.9). Teacher TXH2 also evidenced a higher level of learner-centeredness than the other two teachers; however, this still wasn’t high enough to place her over the cross-over point towards more in than out of learner-centered teaching. The other two teachers were flat and low in learner-centeredness over the three years (See Figure 4.9).

![Figure 4.9 Aggregate Growth Scores For Program 1](image-url)

*Figure 4.9. Inquiry-based and learner-centered growth trends for teachers by their program. Numbers on the left denote teachers’ scores. The exact scale is dependent on the overall scores of the teachers. Numbers on the bottom of the graph represent the 3 years of the study. The colored lines represent each teacher’s actual growth over the three years of the study.*
Program two. Teachers in program 2 showed both variability and flat performance over time. One teacher showed marked improvement, while another plummeted the third year. Two remained at beginning performance levels. Three teachers evidenced a positive trend while the rest began and remained flat over the duration of the study. One teacher showed growth towards inquiry practices (Figure 4.10) and three teachers evidenced growth in learner-centeredness (Figure 4.10) over the 3-year time-span.

Program three. Program three consisted of four teachers. Three teachers overlapped in inquiry-based instructional practices and showed no change over the four years of the project. One teacher began at a high level of inquiry, but also did not demonstrate any change. Two of the teachers overlapped in learner-centeredness and all four evidenced no growth. None of these teachers continued teaching after the second year (See Chart 4.11).
Program four. Program four consisted of only one teacher who evidenced no change over the three years of the project in either inquiry or student-centered practices (Figure 4.12).

Program five. Program five consisted of two teachers whose performance overlapped and evidenced no change over time in their approach to classroom instruction.
Though evidencing an increase in learner-centeredness (Figure 4.13), teacher TCI20 plummeted in the third year to base levels. Neither teacher evidenced a positive trend in inquiry or learner-centeredness.

Program six. Program six had 10 teachers, eight of whom showed no or little change over the duration of the project. Two teachers evidenced change, TFO22 who increased markedly over time (Figure 4.14) and TFO29 who had a positive trend after the second year. Only one teacher, TFO22, evidence marked gains in learner-centered practices over the duration of the project. The rest of the teachers remained relatively flat.
Program seven. Program seven consisted of one teacher who evidenced no change and left teaching in the third year. This teacher made attempts at inquiry (Figure 4.15), but did not know how to engage the students in the suburban school in which he taught.
**Program eight.** Program eight consisted of two teachers who evidenced no change, except TJQ32 left teaching to become a building administrator. She also evidenced a high level of learner-centeredness (Figure 4.16). The other teacher in this program began with leanings toward learner-centered practices, but when he left a high poverty school to teach in a low poverty school, learner-centered practices decreased.

![Figure 4.16 Aggregate Growth Scores For Program 8](image)

Figure 4.16. Inquiry-based and learner-centered growth trends for teachers by their program. Numbers on the left denote teachers’ scores. The exact scale is dependent on the overall scores of the teachers. Numbers on the bottom of the graph represent the 3 years of the study. The colored lines represent each teacher’s actual growth over the three years of the study.

Chart 17 below shows the results of the growth pattern analysis aggregating programs scores on inquiry-based instructional practices. Despite variability, it is evident that three programs had positive trends and five programs had flat trends. Programs 1, 2, and 6 had definite positive trends, while programs 3, 4, 5, 7, and 8 had flat trends. These aggregated program scores do not provide the entire picture of how teachers did by program. Some programs had great variability between teachers, while teachers in other programs were quite similar in their use of inquiry-based instructional practices and learner-centeredness.
Programs’ aggregated learner-centeredness growth trends are displayed in Chart 4.18 below. As discussed previously, the aggregated figures give only a partial picture. However, what can be seen, in spite of wide ranges in teachers’ learner-centered orientations: 4 programs (2, 3, 6, & 7) have positive trends; 2 programs (P4 & 5) have an overall flat trend; and 2 programs (P1 & 8) have negative trends in learner-centeredness. Program 1 had one teacher that was high in learner-centeredness, but she left in the third
year leaving only the two much more teacher-centered teachers, thus the huge dip in learner-centeredness in the third year demonstrating one of the limitations of aggregated data.

**Summary.** The following summarizes the longitudinal data by inquiry-based and learner-centered growth of the teachers by their programs.

**Inquiry.** Five teachers out of 33 showed signs of growth from their first observation over the three years of the study. These five teachers came from Program
One (two teachers), Program 2 (1 teacher), and Program Six (two teachers). Five of the programs graduated teachers that did not evidence any growth in inquiry. This count does not include those teachers that began teaching inquiry above the cross-over point towards inquiry and remained steady in that over the three years of the study. There were two such teachers, one from Program Three and one from Program Five.

*Learner-centered.* Seven teachers had positive growth trends in learner-centeredness over the three years of the study. Three of these teachers came from Program Two, but only two of them were over the cross-over point into the more learner-centered than not membership. The other 4 teachers came from Program Six. However, 3 of the teachers in Program Six evidenced very little learner-centeredness and very little growth, but it was still a positive trend.

*Aggregate Inquiry.* Given positive trends in inquiry-based teaching by graduates from Program One, Two, and Six, none of the programs’ aggregated scores reached the cross-over point into inquiry-based instruction membership. Though a few teachers in these programs and other programs showing no growth did graduate teachers using inquiry-based instructional practices, and some evidencing growth in inquiry-based instruction, teachers levels of inquiry use were disappointing overall.

*Aggregate Learner-Centered.* Aggregate learner-centered scores showed great variability by programs. Three programs showed positive growth trends over the three years, Program One, Three, Six, and Seven. Programs Three and Seven were very slight gains in learner-centeredness. None of the programs, as a whole, placed over the cross-over point in learner-centeredness growth.
Growth trends were disappointing, in that few teachers grew in their use of inquiry or learner-centered practices. Programs did not seem to make much difference in teachers’ ability to begin teaching at an entry level of inquiry or learner-centeredness and then exhibit growth over time. A few teachers did enter at entry levels of inquiry-based practices and learner-centeredness, but they were the exception rather than the rule.

Question Three

Cluster Analysis. There were 10 variables that I considered for the cluster analysis: 1. Program focused on and demonstrated inquiry throughout; 2. Entrance standards; 3. Program focused on and demonstrated learner-centeredness throughout; 4. Exit standards; 5. Program courses were sequenced; 6. Teacher’s age; 7. Teachers professional level of expertise; 8. Content relevance of career; 9. Prior education-relevant experience; and 10. Teachers’ school contexts. However, I wanted to know whether or not a smaller number of factors accounted for the variation among a much larger number of variables. Factor analysis revealed 3 components within the 10 variables: program context, teacher characteristics, and school context. The rotated component matrix is provided below (figure 4.19).
After examining the components, I noted that the factor loadings revealed 3 major concepts/elements that research on teacher performance indicated were important and associated with teachers’ performance in the classroom. These 3 major concepts were the same concepts of which the variables in my data were derived indicating that the variables in my data represented the three concepts I wanted to measure. Then I used a dendogram (Figure 4.20) as a check the number of components revealed. The most
leveling occurred after the third component on the dendogram, helping to confirm three clusters.

Next I looked at the Eigenvalues above one which helped to determine 3 concepts as seen below in Figure 4.21, the Eigenvalues first jump over 1 at 3 clusters. From my analysis of the continuums and from theory on the variables involved I suspected 3 concepts. The Scree Plot (Figure 4.20 above) was unclear and could indicate 2, 3, or 4 concepts. But, since 3 concepts aligned with theory, the Eigenvalues, and did not disagree with the Scree Plot I felt that the three concepts I was measuring were indeed correct. Seventy-two percent of the variance was explained by a solution of three components.
After performing the factor analysis and finding concurrence with my three concepts I went ahead and did the cluster analysis (see Figure 4.22 below) using those variables I used in the factor analysis and which were associated with teacher performance in the classroom as explained in the previous chapter.
To perform the analysis I used SPSS’s Agglomerative Hierarchical Average Linkage (Within Groups). Average linkage “computes an average of the similarity of a case under consideration with all cases in the existing cluster and, subsequently, joins the case to that cluster if a given level of similarity is achieved using this average value”

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Hierarchical methods generally start with all the cases as their own group and then join them together into groups as the process continues.

A first examination revealed three distinct clusters. I used several procedures to determine where to “cut” the dendogram to derive the number of clusters. First, looking at the dendogram it is apparent that there are two major clusters. However, in looking further one of the major clusters has two clusters within it, which appeared to be dissimilar enough to warrant the three clusters.

**Cluster 1: Activity oriented.** Table 10, below, displays the activity oriented teachers by their inquiry-based practices, degree of learning-centered orientation, poverty levels, teacher characteristics and program characteristics. TEACHA, TEACHB, TEACHC, and TEACHD represent respectively teachers’ ages, related relevant teaching experiences, level of professional expertise, and career content relevance. PROGA, PROGB, PROGC, PROGD, and PROGE represent respectively entrance requirements, exit requirements, program sequencing, inquiry-based instruction taught and modeled throughout the program, and learner-centeredness taught and modeled throughout the program.
The Activity Oriented teachers’ inquiry practices ranged from absence of inquiry to partial inquiry. No teacher in this cluster evidenced full inquiry. Their degree of learner-centeredness ranged from full teacher-centeredness to one teacher that moved over the cross-over point into learner-centeredness. Teachers’ school context using FRL figures as a proxy for school environment as explained in the literature review earlier ranged from full poverty to very low levels of poverty. Eight out of the twelve teachers (66%) taught in low poverty schools. Seven of the 12 teachers fell outside of membership in the set of teachers who do best in ATCPs. For this cluster teachers’ ages (TEACHA) was not associated with inquiry-based practices. Teachers with related teaching experience (TEACHB) ranged from no experience to very relevant teaching experience. Teachers’ levels of professional expertise (TEACHC) versus novice levels ranged from

| Figure 4.23 Cluster 1: Activity Oriented Teachers | PROGA: Entrance requirements |
| INQ: Inquiry-Based Teaching | PROGB: Exit requirements |
| LRNCN: Learner-Centered Practices | PROGC: Sequenced program |
| FRL: Free and Reduced Lunches | PROGD: Inquiry-based taught and modeled |
| TECA: Age | PROGE: Learner-centeredness taught and modeled |
| TEACB: Teachers’ relevant education experiences | |
| TEACC: Level of prior professional expertise | |
| TEACD: Career content relevance | |

![Figure 4.23 CLUSTER 1: ACTIVITY ORIENTED](image-url)
novice to expert. Teachers’ careers’ content relevance (TEACHD) to their teaching assignments ranged from no relevance to high relevance.

Teachers’ program components consisted of entrance requirements (PROGA), exit requirements (PROGB), program sequencing (PROGC), inquiry instruction taught and modeled throughout the program (PROGD); and learner-centeredness (PROGE). The teachers in this cluster came from programs that were sequenced or almost fully sequenced. Program Six consistently provided inquiry-based instruction with teacher modeling throughout coursework. But, regardless, the teachers in Program Six ratings were inconsistent and ranged from low to high, though most teachers scored very low on inquiry and higher on learner-centeredness, leading to a tentative conclusion that the programs had little influence on teachers’ inquiry-based instruction and some influence on the development of learner-centeredness.

One explanation for the lack of inquiry, may lay in a common misconception that teachers seem to have about inquiry is equating inquiry with hands-on activities and collaborative group work. Teachers in Program Six consistently used hands-on activities and collaborative group work. However, they seldom posed a question and when they did it lacked substance, for example:

Nate (Teacher TFO29) posed these questions to his students: 1. What is thermal energy, heat, and specific heat; 2. How does a thermometer work; and 3. Why are thermal energy, heat, and specific heat important to physical science? According to Dr. Volkmann (2012), these questions do not lead to productive inquiry leading to an investigation. Students could answer these questions by reading their text book. For Nate to improve his lesson plan, Dr. Volkmann (personal communication, 2012) further stated:
I suggest beginning instruction by asking a question about the mixture temperature obtained when hot and cold liquids are mixed. Student explanations of mixture temperatures can reveal a lot of misconceptions. Ideally, the explanations for predicting a mixture temperature can be tested by investigating other mixtures of hot and cold water. Students should examine the data, and with the teacher’s help, reach an explanation that explains all the data. That is, the class should reach a consensus that energy is conserved in heat transfer phenomena.

Nate evidenced a leaning towards learner-centeredness, in his use of collaborative group work leading students to begin taking responsibility for their own learning, and his role as facilitator during that group work. Over the three years, Nate slowly moved towards inquiry and learner-centeredness, though he did exhibit more learner-centeredness than inquiry.

Ten of the 12 teachers in this cluster evidenced some learner-centeredness and most of this was in the form of hands-on activities. This cluster does seem characterized by programs with similar characteristics and teachers using hands-on activities and/or collaborative group work. Only one teacher in this cluster stands out as an outlier, Heather (Teacher TFO22).

Heather’s first observation lacked inquiry and learner-centeredness. But, over the next two observations she seemed to come to an understanding of inquiry-based instruction and learner-centeredness as she revealed with the following statement:
The purpose of the lesson was to address the problem: “Does the storage temperature of popcorn, affect the number of kernels popped?” The teacher communicated to the students that the purpose of the lesson was for students to learn how to answer a question using a hypothesis and data gathering techniques as a scientist would. The lab instructions were detailed but required critical thinking by the students.

The question/problem was not the most substantive, but it did require that the students derive a hypothesis, collect data, formulate explanations from the data, and connect their explanations to theory, and communicate and support their explanations. Heather still needed to understand how to connect inquiry with the standards she was attempting to meet: Strand 7.a Ability to formulate a testable question and explanation and 7.b scientific inquiry relies upon gathering evidence from qualitative and quantitative observations.

*Summary of cluster one.* For the most part cluster One was characterized by hands-on activities and group work – ten of the 12 teachers. Of the 10, only one evidenced inquiry-based instruction and learner-centeredness placing in the membership set of More or Less in the set of teachers evidencing inquiry-based and learner-centered practices. All of these teachers represented two programs that taught and modeled inquiry-based and learner-centered instruction and sequencing of coursework.

Finally, overall this cluster characterized teachers that used hands-on and collaborative group work. It could be possible, that some teachers need to pass through a phase of learner-centered practices before moving more into inquiry-based practices. One
last thought, Program 6 was based on a cohort model and was not individualized. As strong as its inquiry and learner-centered practices were, perhaps those variables were important for teachers in this cluster. I did not use those two variables in the cluster analysis because I did not have complete information on all of the programs’ use of cohorts and individualization.

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Cluster 2: Under 40/Little Experience. All of the Under 40/Little Experience teachers, above, are below the 40 year-old marker discussed in the literature review. Only one of the teachers had any relevant teaching experience. All of the teachers had 2 or fewer years in a career field, meaning they had little opportunity to develop expertise.

Five of the 8 teachers had careers with little content relevance, two had some relevance, and 1 had a career with high content relevance. Eight of the teachers were fully out of membership in inquiry-based instruction. One of the teachers evidenced some inquiry, but not enough to lie above the cross-over point into inquiry.
Seven of the teachers in Cluster Two taught in high poverty schools below the 40% FRL marker and two taught in lower poverty schools above the 40% FRL marker but not over the cross-over point into low poverty. One of the teachers, (TJQ32, Galen) in the lower poverty schools taught in a high poverty school his first year and then switched to a very low poverty school in which he felt overwhelmed by the level of knowledge of his students. Galen’s background in bio-medical research on the doctoral level (he did not finish) gave him a high level of knowledge in the courses he was teaching, but since the courses were AP level, he felt overwhelmed with the amount of material he had to teach. The low level of poverty in this school combined with the level of instruction expected and the amount of material to be covered caused him to feel that he could not use inquiry and/or have time to develop a learner-centered orientation. So, it seems that the low poverty level for this teacher had the opposite effect that one might expect on his ability to practice inquiry and learner-centeredness.

For the Under 40/ Little Experience teachers, program components of no inquiry and learner-centered instruction and modeling by program instructors; combined with teacher characteristics of age, no teaching relevant experiences, lack of expertise, and little to no career content relevance; combined with high levels of poverty seem to indicate difficulty in using and developing inquiry-based practices and to a lesser degree learner-centeredness.

Cluster 3: 40 and Over/ experienced. The 40 and Over/ Experienced Teachers have higher levels of career experience than the teachers in the other clusters. While this cluster has variability with inquiry and learner-centeredness, they also have higher ratings in inquiry overall. That is a greater percentage of the teachers in this cluster had more
career experience leading to expertise in their field and this cluster also had a greater percentage (50%) of teachers moving towards inquiry-based practices versus the activity oriented teachers with 17% and the Under40/Little Experience cluster with 0%. There was some variability among program characteristics which didn’t seem to influence teachers’ use of inquiry-based practices or their learner-centered orientations. All the teachers in this cluster that had the lowest inquiry scores taught in the highest poverty level schools. Their programs did not stand out as especially inquiry or learner oriented indicating that what the teachers brought into the programs made a difference in how they fared once they became the teacher of record. However, since the need is greatest in high poverty schools, these teachers do not do any better or worse than the other teachers in the two other clusters teaching in high poverty schools. Five of the twelve teachers in this group worked in low poverty schools. Two of the teachers in this 40 and Over/Experienced group worked above the 40% FRL marker but not over the low poverty cross-over point. Five of the teachers worked in schools below the 40% FRL poverty marker. These teachers below the FRL poverty marker fared the worst in practicing inquiry-based instruction as compared to the teachers above the FRL poverty marker. The 4 teachers evidencing low to high inquiry were all from low to lower poverty schools. Six of the teachers in this cluster evidenced some learner-centered characteristics.

Four of the teachers had some relevant teaching experiences, all but one of the teachers had 3 plus years of professional experience, all but one of the teachers rated highly on career content relevance.
Like Activity Oriented cluster, the programs of 40 and Over cluster are similar to each other, except not in the same way. While the Activity Oriented programs evidenced inquiry-based and learner-centered instruction and modeling by the program instructors, the 40 and Over cluster’s programs did not.

The common characteristics of the teachers in Cluster Three seem to lead to a greater percentage of inquiry-based instruction and learner-centeredness when combined with a school context of low poverty. The teachers in Cluster Three experiencing high poverty showed no evidence of inquiry; but three of these teachers did evidence some learner-centeredness.

Cluster Analysis Summary. Over 40/ Experienced Cluster: Ten of the 12 teachers used hands-on activities and collaborative group work, and all but one of them evidenced inquiry-based practices over the cross-over point solidly into inquiry-based practices. Ten of the 12 teachers displayed tendencies towards learner-centeredness, but only one – the
same one evidencing inquiry-based practices – was above the cross-over point solidly into learner-centeredness. All of these teachers represented two programs that taught and modeled inquiry-based and learner-centered instruction and sequencing of coursework. The variety among teacher characteristics and school poverty levels combined with programs strong in demonstrating and teaching inquiry-based and learner-centered instruction with the outcome of 83% of the teachers evidencing no inquiry-based practices is perplexing. However, 83% of these teachers did evidence learner-centered strategies even though not high enough for most to be placed over the cross-over point.

A tentative conclusion could be that some teachers may find it easier to develop learner-centeredness before developing inquiry-based practices. One other factor to consider is that these teachers may be equating hands-on and collaborative group work as inquiry, which is a common misconception among teachers. A commonality of this group minus one outlier, is hands-on activities and collaborative groups indicative of learner-centeredness, with none or only one essential feature of inquiry present. A final factor not measured in all the programs for lack of data, but available for program 6, was the cohort model employed by program 6 and the lack of individualization may have been a factor for this specific group of teacher candidates. I mention this because the majority of the teachers in this cluster are from program 6.

The Under 40/ Little Experience teachers’ characteristics of interest included: 1. all teachers fell below the 40 year-old threshold discussed earlier; 2. all but one teacher had no relevant teaching experience; and 3. all but one teacher had 2 or less years of professional experience. Program characteristics stood out notably for their similarity
except in sequencing of coursework and for the absence of inquiry-based and learner-centered instruction and modeling by program instructors.

The Under 40/ Little Experience teachers did not evidence inquiry-based practices to any degree except for one teacher whose practice still did not lie above the cross-over point towards inquiry. Learner-centeredness ranged from an absence to two teachers over the cross-over point towards learner-centeredness. These teachers’ membership in the set of teachers under 40 years-of-age, lack of teaching experience, and lack of professional expertise in any career field combined with programs that were weak in inquiry and learner-centered instruction is associated with their lack of inquiry-based instruction. However, 55% of these teachers did evidence learner-centered orientations with two of these teachers reaching over the cross-over point towards learner-centered teaching.

A tentative conclusion is that a lack of inquiry-based practices is associated with teachers whose ages are lower than the 40 year marker, with little professional experience, and little to no relevant teaching experiences when combined with programs that do not explicitly teach and model inquiry-based instruction.

Like the Activity cluster, the programs of the Over 40/ Experienced teachers are similar to each other, except not in the same way. While the Activity Oriented teachers’ programs evidenced inquiry-based and learner-centered instruction and modeling by the program instructors, the Over 40/ Experienced teachers’ programs did not.

The common characteristics of the Over 40/ Experienced teachers seem to lead to a greater percentage of inquiry-based instruction and learner-centeredness when combined with a school context of low poverty. The teachers in this cluster experiencing high poverty showed no evidence of inquiry; but three of these teachers did evidence
some learner-centeredness. The Over 40/Experienced teachers align with the thinking of alternative teacher certification proponents, that professional experience approaching expertise and teacher’s maturity (age as a proxy) may be sufficient to develop inquiry-based and learner-centered practices within low poverty schools. The Over 40/Experienced teachers that did the best with inquiry and learner-centeredness had professional careers that allowed them to develop depth and expertise in their field.

Finally, the cluster analysis points to several associations:

- Learner-centered practices, but not inquiry-based practices are associated with programs strong in inquiry-based and learner-centered practices instruction and modeling by program instructors in combination when combined with low poverty schools and a lack of relevant teaching experience.

- Teachers under 40 years-of-age, lacking education-relevant experience and professional expertise in any career field combined with programs that were weak in inquiry and learner-centered instruction are associated with the absence of lack of inquiry-based and learner-centered instruction.

- Inquiry-based and learner-centered practices are associated with teachers who are 40 and over, who have professional expertise, and who have career content relevance when combined with a low poverty school context.

In summary, we often speak about the complexity of the act of teaching and the blending of skills, knowledge, abilities, personality, and contexts with which teaching is associated. But, we often attempt to look at the act of teaching in a linear fashion trying to find relationships that hold true across a population, when, in fact there may be more
than one relationship among variables or more than one configuration of variables or characteristics that lead to the same outcome.

This study was exploratory and aimed to look at a variety of variables and characteristics associated in the literature with teachers’ instructional choices. Further, the focus has been on inquiry-based and learner-centered practices and the combinations or configurations of variables or characteristics associated with teachers’ inquiry-based and learner-centered instructional decisions.

The importance of scientific literacy drove this study focusing on the National Research Council’s first and second standards: inquiry-based instruction and teachers as facilitators and guides or learner-centered practices. Given the importance of scientific literacy and the documented power of inquiry-based and learner-centered practices whether or not alternatively certified teachers are able to effectively use inquiry-based and learner-centered practices at an entry level upon entering the classroom as the teacher of record and whether or not they experience growth over time in those practices is important to document. That is what this study aimed to do along with focusing on the combinations or configurations of different teacher characteristics, program characteristics, and school contexts which were associated with the teachers’ use of inquiry and learner-centeredness.

This first part of my study looked at teachers’ instructional practices and specifically documented their inquiry-based and learner-centered practices and their growth patterns over time using two continuums developed for this study. The inquiry-based practices continuum was developed in consultation with an inquiry expert (Volkmann, personal communication) and the research literature on inquiry, as well as
the NRC’s first science education standard and its five essential features as the
foundation of the continuum. The learner-centered continuum was developed using the
literature on learner-centered practices, the NRC’s 2nd science standard, and Weimer’s
(2002) five characteristics of learner-centered practices as well as Huba and Freed’s

The continuums revealed that most of the teachers in this study did not effectively
use inquiry-based or learner-centered instructional practices regardless of program,
however, most of the teachers were much more teacher-centered in their practices than
inquiry-based. Of the teachers within the non-traditional grouping only one evidenced
both inquiry-based practices and learner-centered practices. The rest either were learner-
centered or inquiry-based. The continuums, by themselves, were only able to reveal what
happened in the classroom. But the continuums laid a foundation for understanding the
rest of the analyses. The continuums made it possible to juxtapose the teachers’ inquiry-
based and learner-centered practices along side of the cluster elements to best understand
the clusters.

Teachers’ growth patterns were disappointing. Growth, when it occurred did not
impact teachers’ scores to any extent. That is, teachers that began low on inquiry and
learner-centeredness stayed low or plummeted throughout the 3 years of the study.
Growth is an important assumption noted in the research literature. Teachers are expected
to enter teaching with entry level skills and the knowledge and ability to grow in those
skills and knowledge. The overall lack of growth in these teachers is a problem, given
that research has also suggested that many teachers seem to grow for the first few years
and not much growth in their practices is evidenced after 5 years regardless of advanced degrees.

The second part of my study moved away from the teachers’ performance and into the specific teacher, program, and school context characteristics that have been documented and/or thought to impact teachers’ instructional decisions in the classroom. The cluster analysis clustered teachers by their teacher, program, and school context characteristics and revealed three groups of teachers that were analyzed for group structure and for differences between the groups. The cluster revealed two clusters which were associated with a lack of inquiry and/or learner-centeredness and one cluster which was associated with the presence of inquiry and learner-centeredness. The configurations were as follows:

- **Activity Oriented Teachers** evidenced some learner-centeredness, naive inquiry-based practices; and were associated with programs strong in inquiry-based and learner-centered practices instruction and modeling by program instructors in combination with low poverty schools and a lack of relevant teaching experience.

- **The Under 40/ Little Experience** teachers with no relevant teacher experience, no professional expertise, and little career content relevance, combined with school contexts of high to medium poverty and programs lacking strong inquiry-based instruction and modeling by program instructors were associated with an absence of inquiry-based practices and low to no learner-centered practices.

- **The Over 40/ Experienced** teachers with professional expertise and career content relevance combined with a low poverty school context were associated with
Inquiry-based and learner-centered practices. Teachers in this group in higher poverty school contexts fared the same as other teachers in the study.

CHAPTER 5
DISCUSSION AND CONCLUSIONS

My study did to some degree support the alternative teacher certification proponents’ claims, in that more mature and career experienced teachers did bring skills with them that generalized to the classroom setting and seemed to give them an edge in creating inquiry-based and learner-centered classrooms, as long as they were teaching in low poverty schools. However, this study did not find a relationship between teachers’ education relevant experiences and their inquiry-based or learner-centered orientations as did the Akiba-Scribner study. This may be partially due to this study’s use of a different scale for measuring the teachers’ inquiry-based and learner-centered practices. My study focused on only one aspect/one standard within the NSF’s concept of Inquiry teaching. While the Akiba-Scribner study was more holistic and measured the teachers on a scale that captured all five of the NSF’s standards.

In this study, the three clusters – Activity-Oriented, Under 40 with Little Experience, and the Over 40 with Experience – help clarify the conditions associated with inquiry-based and learner-centered practices among the teachers. Though the findings in my study are tentative pending a more thorough validation and reliability testing of the instruments and procedures used to derive the continuums and to calibrate the measurements of variables, they do suggest the possibility of finding combinations of
the elements impacting teachers’ practices and using that to inform teacher educators and policy makers about the needs of prospective alternatively certified teachers and how ATCPs could respond to those needs. The following summary with implications is drawn from the outcomes of this study.

**Three Types of Teachers’ Practices: Decided, One-Sided, and Traditional**

Three types of teacher practices emerged during analysis of the teachers’ instructional practices: Decided, One-Sided, and Traditional; however the majority of the 33 teachers in this study demonstrated little understanding of inquiry-based instruction or learner-centeredness. Only one teacher showed an understanding of both inquiry-based and learner-centered practices – Decided type. Four teachers demonstrated understandings of inquiry, while lacking learner-centeredness orientations – One-Sided type. Three teachers demonstrated a learner-centered orientation, but lacked inquiry-based practices – One-Sided type. And the majority (25) of the teachers fell into the traditional type to varying degrees bordering on crossing into the Non-traditional types (Decided and One-Sided) to almost total Traditional type.

**Implications**

Programs are not providing targeted inquiry-based and learner-centered instruction that meets teachers’ needs. The following sheds light on teacher deficits that programs may need to take into consideration in preparing science teacher courses.
Clusters by Teacher, Program, and School Characteristics: Activity-Oriented, Under 40 with Little Experience; and Over 40 with Experience

**Activity-Oriented.** Activity-Oriented teachers in this study had little career experience and displayed an understanding of the use of activity to strengthen learning, but did not understand how to tie that to inquiry or learner-centeredness in spite of coming from programs demonstrating strong inquiry-based and learner-centeredness orientations.

**Implications.** Teachers, regardless of age or career experience, entering programs strong in inquiry and learner-centered orientations tend to be activity-oriented, but do not display strong understanding or practice of inquiry or learner-centeredness. Programs need to find a way to help teachers move beyond activity for activities sake to inquiry-based and learner-centered activity. This may involve a dedicated course where teachers learn through case studies and videos how to distinguish between the two and courses specifically guiding teachers in preparing inquiry-based and learner-centered units and lesson plans for their specific school context that can be used in their immediate teaching position with an inquiry mentor.

**Under 40 with Little Experience.** The Under 40 with Little Experience cluster of teachers demonstrated little inquiry, but two teachers scored high on learner-centeredness. However, scores on both domains were lower overall than the Activity-Oriented teachers. Only one teacher in this group demonstrated any evidence of inquiry-based teaching – 11%, while two teachers demonstrated strong learner-centered orientations – 22%. A notable difference between this group and the Activity-Oriented
group was that their programs did not demonstrate strong inquiry-based or learner-centered approaches.

**Implications:** Individuals under 40 with little to no career experience and an ATCP that is not strong in inquiry-based and learner-centered instruction will not pick up these orientations on their own. These teachers will need help in developing orientations towards inquiry-based and learner-centered practices. If inquiry-based and learner-centered instructional practices are the best practice in science teaching and learning, then more programs will need to make this an emphasis, especially for teacher candidates with little to no career experience. The same types of course would apply for this group as with the activity-oriented cluster.

**Over 40 with Experience.** The Over 40 with Experience cluster of teachers had the greatest percentage of teachers evidencing the highest levels of practice and understanding of inquiry-based and learner-centered practices combined. That is, these teachers tended to demonstrate both inquiry and learner-centeredness but were in general stronger in their inquiry-based practices. These teachers did not come from strong inquiry-based or learner-centered programs, but 75% had five or more years of professional experience. Notable within this group is that the teachers that did best taught in low-poverty schools.

**Implications:** Individuals in this cluster tended toward inquiry-based practices and demonstrated them when teaching in lower poverty schools. These teachers’ practices in spite of programs that did not demonstrate inquiry or learner-centered practices demonstrated inquiry-based and learner-centered practices and would benefit from programs strong in inquiry-based practices and learner-centered orientations. Unlike
the Activity-Oriented group, these teachers seemed to understand the difference between just preparing an activity and creating an inquiry-based and learner-centered environment.

**Little demonstrable growth in inquiry-based and learner-centered practices**

Very few teachers advanced beyond their beginning levels in inquiry-based and learner-centered practices. Five of 33 teachers demonstrated strong positive growth towards inquiry-based practices – 15%. Four of 33 teachers demonstrated strong positive growth towards learner-centered practices – 12%. Teachers tended to stay at the level of practice in which they entered. Teachers that entered strong in inquiry-based practices did not demonstrate much growth beyond entry level and the same held true for learner-centered orientations. However four teachers demonstrated significant growth in inquiry-based practices over the three years of the project.

**Implications.** The majority of the teachers were not ready to enter teaching and continue growing in inquiry-based or learner-centered practices. Teachers may need more time to develop these skills before entering a classroom, but given the ATCP emphasis of early entry in the classroom while learning how to teach, then one implication may be for stronger mentoring in inquiry-based and learner-centeredness.

One implication arising from the overall analysis is that mentoring programs may need to take a more prominent role in guiding novice teachers through the maze of activities a first-year teacher experiences. Teachers need mentors that are versed in inquiry-based and learner-centered orientations. One finding, not mentioned previously is the struggle many of these teachers had with classroom management – when a teacher is
struggling with classroom management it is doubtful that they can focus on preparing inquiry-based and learner-centered classrooms, hence mentoring in this area as well may lead to improvement in teachers’ instructional practices.

My study did not use mentoring in the analysis because not enough information was available on each teacher’s mentoring experiences. The mentoring data did not specifically note mentor’s inquiry-based or learner-centered knowledge base or ability to provide mentoring in that area. What information was available was at times contradictory, but did lean towards inadequate mentoring whether or not the teachers’ mentors were proficient in inquiry-based and learner-centered practices.

Research Implications

Extending the model of my study is a next step in the research process. Certain limitations made it difficult to quantify and analyze the data as sharply as I would have liked to do. The scales I created need further refinement and need to be validated and tested for reliability.

Another further step would be to refine the measure of the variables that I used and use fuzzy-set qualitative comparative analysis to best understand the configurations that I found existing in the cluster analysis. Final recommendations for future research include:

- Conduct a follow-up study on the participating teachers in this study would make the findings in this study stronger and would provide better growth analyses

- Refine the measures through data collection that better reflect the parameters of my study’s emphasis
• Validate the scales and further refine them for use in measuring teachers’ inquiry-based and learner-centered practices.

• Add the rest of the NRC standards to my model for further refinement.

• Create typologies of teachers based on their presenting characteristics before entering an ATCP to aid teacher educators in planning more tailored programs.

• Consider looking at teachers’ practices holistically and use non-linear analyses that provide configurations associated with outcomes, one such which is fuzzy-set qualitative comparative analysis.

• Researchers should consider studying the efficaciousness of including specific coursework in preparing units and lesson plans for immediate use since most ATCP teachers are teaching as they attend classes.

Policy Implication

• Mentoring could be an important part of ATCPs, however to provide teachers with the amount and type of mentoring necessary to reach proficient levels of inquiry-based and learner-centered practices may require stronger and more specific policy.

Teaching, whether it is of teachers or Pk-12 students is complex. Previous studies have relied on analytical techniques that have not been able to unravel the complexity in a way that preserved non-linear relationships. This study began to delve into a technique that aims at preserving those non-linear relationships: fuzzy-set Qualitative Comparative Analysis. The idea of configurations was directly borrowed from fsQCA as well as the calibration techniques of fsQCA.
This study’s findings suggest that fsQCA thinking might be a way of unraveling the complexity of teaching while preserving non-linear relationships among variables to understand how, when, and why teachers’ use inquiry-based and learner-centered practices. The use of fsQCA to provide configurations with associated outcomes could help teacher educators create differentiated programs that take into account the conditions that are associated with specific inquiry-based and learner-centered practices.

Conclusion

This study focused on the instructional practices of alternatively certified science teachers exploring the configurations of teacher, program, and school contextual characteristics that are believed to contribute to instructional decisions. I used quantified qualitative data to create continuums of inquiry-based and learner-centered instruction to measure teachers’ use of inquiry-based and learner-centered instructional practices and analyzed those. I also created growth trends for the study teaches covering the three years of the study and analyzed those. Then I performed a cluster analysis using measures of teacher, program, and school context characteristics and analyzed those. Finally I synthesized those findings and discussed implications, future research possibilities, and summarized policy and educator recommendations.

In conclusion, my study was exploratory and aimed to add to the literature and make recommendations for future research on the relationship between alternatively certified science teachers and their instructional practices; and provide insight for and make recommendations to teacher educators and policy makers about alternative teacher certification programs and how they could better meet the needs of career and degree
changers. I have, to a degree, been able to accomplish the above. The answers to my study’s questions require a different response from teacher educators and policy makers than they have made to date when thinking about the relationships between teachers, programs, and schools. I close with this thought, “We can’t solve problems by using the same thinking that we used when we created them” (Einstein)
REFERENCES


Retrieved March 5, 2010, from

http://www.state.nj.us/education/educators/license/research/alternate.pd


http://online.wsj.com/article/SB10001424052748704461304576216911954533514.html

153


155


Teacher Quality. CA: Hoover Institution Publication Press.


Hanushek, E. A., Kain, J. F., & Rivkin, S. G (1999). Do higher salaries buy better 

teachers. In D. Ravich (Ed.), Brookings Papers on Education Policy 2004 (pp. 7-

Haycock, K., & Huang, S. (2001). Are today’s high school graduates ready? Thinking K-

Huba and Freed (2000). Teacher Centered Vs Learner Centered Paradigms Available: 
http://assessment.uconn.edu/docs/Teacher

effective alternative teacher certification programs. Teachers College Record,
110(4).

Publication.

 improvement. Bloomington, IN: Phi Delta Kappa Press.

Khan, M. A. (2009). Teaching of heat and temperature by hypothetical inquiry approach:
A sample of inquiry teaching. Journal of Physics Teacher Education Online.
Retrieved April 7, 2012. Available:

http://www.phy.ilstu.edu/jpteo/issues/jpteo5(2)aut09.pdf


National Capitol Language Resource Center (ND). Retrieved 04/15/2012 available online [www.nclrc.org](http://www.nclrc.org)


160


Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. University of Tennessee Value Added Research and Assessment Center, Knoxville, TN.


Clearinghouse on Higher Education and the Association for the Student of Higher Education.


Teacher-Centered vs. Learner-Centered Paradigms

[http://assessment.uconn.edu/docs/Teacher](http://assessment.uconn.edu/docs/Teacher)


APPENDIX

Appendix A. Teacher Interview Template

This template was used for the teacher interview and is used in understanding which teacher perspectives, and teacher, program, and school characteristics influence teachers’ use of evidence-based practices in the classroom. It is also used for triangulation with data collected through the POS and the teacher survey.

Part I: The program interview

Teacher Characteristics

○ Think back to when you started this career change. What made you decide to be a teacher?
  ○ In what ways are you satisfied or dissatisfied with your decision to become a teacher? (triggers: e.g., job satisfaction, salary, preparedness, work conditions?)

○ How long do you plan to stay in teaching? What factors have influenced your decision to stay or leave teaching (e.g., family considerations, salary, work climate, etc.)?

○ Do you foresee yourself staying in public education but moving into a non-teaching position (e.g., assistant principal, principal, technology/media specialist, etc.)?
  ○ If so, what factors would influence that decision?

○ What aspects of your professional work experience prior to teaching have been most useful to you as a classroom teacher?
  ○ In what ways? (Probe on content knowledge, experiences in other organizations, experience working with children, experience in activities related to teaching and learning, etc.)

○ What aspects of your general life experience prior to teaching have been most useful to you as a classroom teacher?
  ○ In what ways?

PROGRAM PERSPECTIVES
Think back over your preparation experience. Now that you have some experience teaching, tell me your thoughts about the quality of your preparation experiences.

What types of knowledge and/or skills did your preparation program offer you that have helped you MOST in your teaching? Please explain and provide examples.

What types of knowledge and/or skills did your preparation program offer you that have helped you LEAST in your teaching? Please explain and provide examples.

School Support

To what extent are you satisfied or dissatisfied with your situation in this school? Describe the factors that contribute to your satisfaction or dissatisfaction?

How many years have you been at this school? What are the chances you will return to this school next year? Why?

To what extent (and in what ways) are you able to apply what you learned in your preparation program in your classroom instruction?

What is it about this school that facilitates (or impedes) the application of that knowledge or those skills?

How supported do you feel at this school to be an effective teacher?

To what extent does that support come from (Please describe):
  - Teachers in general
  - Teachers in the same subject area
  - Your mentor teacher
  - Administrators

Do you receive the kind of support you need when you seek it?

Part II: The classroom observation interview

CLASS OBSERVATION

What was the purpose of the lesson and how did it relate to the goals of the larger unit?

- What instruction had this class experienced related to these concepts prior to the session?
○ What problems understanding the material did you expect your students to have?

  • Where did your ideas about these potential misunderstandings come from? (e.g., experience, your preparation program, mentor teacher, other teachers, etc.)

○ How did you assess understanding for the material covered in the class I observed?

  • How did this fit into your assessment plan for the larger unit?

○ What particular areas of the lesson do you feel were most effective? Why?
  ○ What changes, if any, would you make if you were to teach it again? Why?

  ○ What needs to come next for this class in developing their understanding of the concepts?
Appendix B: Teacher Observation Field Note Write-up Template

Teacher Observation || Date: || Teacher name: || ATCP: || School: || grade: ||

Number of students: || Observer || DOC ||

Descriptive information

Descriptive information

Design of the Lesson

Implementation/Pedagogy

Culture of the classroom

Physical environment
VITA

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