Science Opportunities for all Students:
A Study Examining the Quality of Inquiry-Based
Science Instruction in Southeastern Ohio

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This thesis titled
Science Opportunities for all Students:
A Study Examining the Quality of Inquiry-Based
Science Instruction in Southeastern Ohio

by

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ABSTRACT

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The purpose of this study was to examine and describe the status of Inquiry-based science instruction in Southeastern Ohio public high schools. The project specifically targeted teachers’ beliefs and perceptions concerning inquiry and Inquiry-based science teaching, the extent to which they relied on inquiry strategies in the classroom and the various factors that could act as barriers in their use of inquiry. The Science Instruction and Facilities Survey (SIFS) was developed for the project and served as the main research tool. Results suggest that many teachers are familiarized with instances of inquiry in their teaching but lack the know-how to view it as a process of science geared towards scientific literacy and analytical skills. Findings also suggest that although teachers may believe inquiry should be utilized on a frequent basis in the classroom, their practice may not reflect this belief. Time, class size and available materials emerged as important factors that influence teachers’ use of inquiry.

Approved: _____________________________________________________________

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CHAPTER ONE: INTRODUCTION

The *National Science Educational Standards* (NSES) center on the development of scientific literacy in students and promote Inquiry as the “central strategy for teaching science” to meet those goals (National Research Council, 1996). Inquiry forms part of a quality Science experience. “Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (NRC, 2006, p.23). The National Science Education Standards (2001) state that:

Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information, to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (p.23)

Inquiry, then, is a process that enables the learner to produce scientific knowledge (NRC, 1996). Scientific Inquiry refers to the different activities through which “students develop knowledge and understanding of scientific ideas” (NRC, 2006, p.23). This deep scientific knowledge becomes a fundamental goal of inquiry teaching and learning, where students are involved in the identification of assumptions based on observations, which in turn promote a critical thinking process. Inquiry, as the process of science, creates an
environment that fosters discovery, the development of hypotheses, experimentation and real life application. Inquiry-based teaching and learning are advocated as essential components of the science classroom, laboratory investigations, and field investigations.

Laboratory investigations (labs) are mostly required at the high school level. In a position statement on the importance and role of lab investigations in Science, the National Science Teachers’ Association [NSTA] (2007), has declared that:

Developmentally appropriate laboratory investigations are essential for students of all ages and ability levels. They should not be a rote exercise in which students are merely following directions, as though they were reading a cookbook, nor should they be a superfluous afterthought that is only tangentially related to the instructional sequence of content. [They] should incorporate ongoing student reflection and discussion. (p.1)

Labs need to be reflective, relevant, and accessible for all students. “For science to be taught properly and effectively, labs must [also] be an integral part of the science and inquiry curriculum (NSTA, 2007, p.1). This calls for a paradigmatic change in how labs are conducted, moving towards an inquiry approach. Interestingly, many science teachers use the terms “science inquiry” and “laboratories” interchangeably, often confusing one with the other. (Wallace, C. S., Kang, N., 2004). Labs have been defined as places or locales “equipped for experimental study in a Science or for testing and analysis; [places] which provide the opportunity for experimentation, observation or practice in a field of study” (“Laboratory”, 2009). Laboratories, then, comprise a location for science rather than a process of teaching.
“Laboratory experiences provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models and theories of science” (NRC, 2006, p.93). As part of this process, students should be able to interact and draw connections to scientific theories through the use of inquiry strategies. The inquiry process promotes direct observation but also requires students to think critically and analytically. Science curricula and teaching practices should purposefully adopt such inquiry-based experiences that meet the needs of all science students (Perkins, 2006).

Inquiry in the State of Ohio

Legislative measures have been taken in the State of Ohio in order to ameliorate for the science learning opportunities for Ohio students. Edicts such as the Ohio Core are faithful advocates for equal opportunities to all Ohioans alike. The heart of the Ohio Core looks to “prepare Ohioans to apply increased knowledge and skills to meet the demand of the 21st century” (Ohio Core, 2007, p.1). As of July 1, 2010, Ohio high school graduation requirements in science will require students to have participated in “inquiry-based experience[s] that engage students in asking valid scientific questions and gathering and analyzing information” (Ohio Core, 2007, p.1). This implies that Ohio students need to complete one unit of physical sciences, one unit of life sciences and one unit in an advanced study course such as Chemistry, Physics, advanced Biology or an Earth Science course (Ohio Department of education, 2007). In fact, currently students are asked to spend 120-150 hours for each advanced study course requiring laboratory experimentation component work in Ohio high schools (Ohio Department of Education,
2007). Furthermore, the Ohio Academy of Science has a strong commitment towards the implementation of meaningful science lab experiences for Ohio students. The academy is advocating that students do more than observations in science. In a position statement on the science requirements for the State of Ohio, the Ohio Academy of Science (2007) stated:

Students will be actively engaged to learn science or as put by the Ohio Core language: immerse in an inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information. (p. 5)

Teacher Beliefs and Practices

In addition to emphasizing the importance of inquiry-based science for students, the Ohio Academy of Science highlighted the influential role that teachers play in promoting inquiry-based science experiences by stating:

This distinction [Inquiry-Based learning] is a paradigm-shift in the way high school science must be taught and is at the heart of the Ohio Core… Rather than teachers demonstrating science, or simply explaining scientific concepts, now students will be expected to do science. The roles of teachers and students must change. No longer will a Science teacher be viewed as ‘sage on the stage’. Now he or she must become a ‘guide on the side’. (OHIO Academy of Science, 2007, p. 5)

Teachers play a very influential role in facilitating inquiry for science teaching and learning (Chiappetta and Adams, 2004; Misakian and Haycock, 2003; NRC, 1996).
Teachers’ knowledge and beliefs about science teaching impact the kinds of practices they adopt in their classrooms, and subsequently student learning (Brown and Melear, 2006; Kang and Wallace, 2004).

Rural Ohio

“Most rural areas lack both the population and taxable property base to generate the educational funding needed by today’s standards” (Chao, Horn and Ogden, 1995, p. 21). This lack of funding may pose challenges to the use of inquiry in rural schooling. Research is needed to better understand the context, environment, opportunities and/or limitations ruralness contributes to inquiry-based science teaching and learning. In order to discuss science instruction in rural school locations, a better understanding of the term rural and its implications is needed.

The notion of what rural schooling involves has been considered a challenging one since investigations have suggested and “[revealed] a lack of distinction between criteria for ‘small’ schools versus ‘rural’ schools” (Baird, et al., 1994, p.556). Some researchers have split ruralness into different categories according to census-defined territories and their distance from urbanized areas or cities (Provasnik et al., 2007). In Ohio, the immense spread of roughly 1.5 million people among 29 different counties puts in perspective for us the distant and, in many cases, rural nature of this region. These numbers also reflect the limited physical, economic and social opportunities which many of these secluded areas encounter. The Southeastern region of Ohio constitutes the largest part of Appalachian Ohio. Counties included in this range count for more than one third of the total territorial expansion of the State. Based on these indications we can
distinguish then how most of the schooling designation in the State of Ohio could be considered rural. These vitals make the study of inquiry-based science lab opportunities in Southeastern Ohio a desirable and fascinating investigation.

Rural Appalachian Ohio has also experienced the consequences of limited developmental opportunities in many areas. Social, ethnic and economic disadvantages, for many years, have consequentially provided straggled developmental opportunities to this region (Ohio Department of Development, 2003). Appalachian Ohio forms part of the Appalachian range, defined by the Appalachian Regional Commission (2007) as:

A 205,000-square-mile region that follows the spine of the Appalachian Mountains from southern New York to northern Mississippi. It includes all of West Virginia and parts of 12 other states: Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia. (“The Appalachian Region”, 2007)

Statement of the Problem

Inquiry-based teaching and learning are a cornerstone of science reform efforts nationally and in the State of Ohio. Even though much has been said about how inquiry-based activities form important descriptors of a quality science experience (Aldous, 2008; Baird et al., 1994), inquiry has failed to become a reality in many schools (Wood et al., 2006; Perkins, 2006). Unfortunately, schools that have suffered the consequences the most are ones that are mainly rural in nature, often with the least amount of funding or
support from their districts (Chao, et al., 1995). The translation of the reform discourse into the classroom is jeopardized by several factors, including:

1. The ability of teachers to facilitate inquiry teaching and learning, and
2. The limited physical, economic, and social opportunities in the Southeastern part of the State.

Understanding teachers’ beliefs and practices pertaining to inquiry provides better insight into their ability to facilitate inquiry teaching and learning. Teachers’ beliefs and practices serve to shed light on the status of science teaching and learning in Southeastern Ohio. Even when teachers understand inquiry, their role as facilitators for the different kinds of inquiry-based science experiences that take place in the classroom could well be compromised when faced with limited resources and support (Cavanagh, 2007). The limited developmental opportunities and prevalent poverty (Chao et al., 1995) in some areas of the state of Ohio could possibly act as barriers to the implementation of OHIO CORE requirements for science instruction (Ohio Department of Development, 2003).

Purpose of the Study

This research project set out to explore the status of inquiry-based science teaching and learning experiences in the rural context of Southeast Ohio. Specifically, the project investigated the following research questions:

1. What are teachers’ beliefs and perceptions of Inquiry-based science?
2. To what extent do teachers in rural schools rely on Inquiry-based strategies for teaching science?
3. What factors (e.g. sample demographic variables, school designation, OGT Science graduation scores, facilities, teacher beliefs etc.) influence teachers’ use of Inquiry-based strategies for teaching science in rural settings?

Significance of the Study

Whether Ohio students become scientists, doctors or homemakers, inquiry-based science instruction has the power to positively influence students’ scientific literacy and prepare them for the future. Therefore it is important to investigate the kinds of science experiences in which students participate. Teachers remain the largest influence on the type of science experience available to students. Investigating the inquiry knowledge, beliefs, and practices of high school teachers can yields results that have the potential to impact pre-service and in-service teacher education.

Findings from this study offer better insight into the impact that teacher training, professional development, school facilities funding, and other factors have on teachers’ use of inquiry. Results will have implications for policy and practices that can be adopted in order to lessen the impact of such factors. Residents in rural areas identify very closely with their local communities and greatly value them (Harmon, Henderson, & Royer, 2002). “In Appalachian communities, poverty, isolation and lack of resources too often combine to create cultures in which people [also] suffer from low expectations and fatalistic attitudes” (Harmon et al., 2002, p.1). Awareness of the physical, social, and emotional elements that impact Southeastern Ohio culture is necessary for transforming science teaching and learning in rural schools through inquiry (Aldous, 2008; Cavanagh, 2007).
Limitations of the Study

Several factors limit the scope of this study. Because of the self-report nature of the survey, it would be difficult to judge whether a participant misrepresented information by responding in an exaggerated or random manner. A low response rate also limits the results of the study. A low response rate may result from a lack of teacher participation encouragement from school administrators or participants’ willingness to complete the survey.

Definition of Terms

For the purpose of this study, the following terms are defined as follows:

1. **Laboratories**– places equipped for experimental study in Science and/or for testing and analysis. They provide the opportunity for experimentation, observation or practice utilizing inquiry as a central component.

2. **Inquiry-Based Instruction**- refers to instruction geared towards active learning where students develop knowledge and understanding of scientific ideas. It is the process of science by which students generate scientific reasoning and critical analytical skills. (NSES, 2001)

   a. **Open Inquiry**- method were students become the focus throughout the inquiry process by allowing them formulate questions and design their own activities with minimal intervention from the teacher.

   b. **Guided Inquiry**- method where the teacher assists students in developing their investigations or lab activities. Hence, the teacher serves as a guide to meet activity goals.
c. **Coupled Inquiry**- combines Open and Guided Inquiry. This form of inquiry uses the Guided method as a starting point and then allows students to take ownership of their investigation through the Open method.

d. **Structured Inquiry**- students follow prescribed steps and are limited mainly to teacher directions.

3. **Rural**- Locations distanced by more than five miles from urbanized communities. It refers to areas secluded by geographical limitations and far from larger sized cities or communities.

**Organization of the Study**

This first chapter introduced and defined the scope of the study, presenting the focused research questions. Chapter two presents a review of existing literature that supports the purpose of the study and synthesizes the findings of similar or relevant studies. Chapter three describes the methodology used for the study. Chapter four presents and discusses the results of the study and closes by providing an ample discussion of the findings, conclusions and further recommendations.
CHAPTER TWO: LITERATURE REVIEW

In the State of Ohio, inquiry is considered the foundation for quality science instruction. State content standards express that “students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information” (Ohio State Board of Education, 2004, p.19). This in turn fosters and encourages instruction where scientific inquiry becomes the key to meaningful science experiences. This chapter begins with a definition of inquiry as an instructional strategy followed by a review of existing literature about teachers’ inquiry beliefs, teaching practices, and any barriers to the implementation of inquiry science teaching identified in the literature.

Inquiry as an Instructional Strategy

Inquiry-based instruction implies that inquiry methods are used and employed throughout the whole science instruction experience; from discussing a theory to applying it by experimentation (Ohio Academy of Science, 2007). Inquiry as an instructional strategy encourages students to pose genuine questions about science and the natural world, and engages them in active investigations, discovery and learning (Wood, Lawrenz, Huffman, Schultz, 2006). Inquiry fosters in students the desire to investigate, formulate hypotheses, interpret data and draw conclusions through the use of critical and logical thinking skills that help solve life’s dilemmas and science interrogatives.

Various researchers have identified other components that are desirable and should be sought out as part of inquiry instruction (Baird, Finson, Oliver, Prather &
Preston, 1994; Wolf and Fraser, 2008). As a multifaceted process, inquiry-based science teaching poses the ability of being utilized to various degrees. This allows teachers to manipulate the extent to which inquiry is used in the classroom. Several types of Inquiry practices have been identified and are worth pointing out.

Open Inquiry, also known as “Full Inquiry”, is unique in that it relies on and begins with genuine questions students formulate and with groups they form in order to design and conduct their own experiments based on their original interrogatives. A key aspect of this type of Inquiry is that the student becomes the focus throughout the process, allowing open room for observation, critical thinking and conclusions (Colburn, 2006; Martin-Hansen, 2002).

With Guided Inquiry the teacher assists students in developing investigations in the Science classroom or laboratory. In this instance the teacher serves as a guide, choosing and presenting students with a question to be investigated by them. “Teachers [also] find that this is a time when specific skills needed for future investigations can be taught within context” (Martin-Hansen, 2002, p.35). Guided Inquiry is a pre-cursor and good practice for students to be led into Open Inquiry as their critical thinking skills progress.

A third type of Inquiry combines Guided and Open Inquiry methods. This type is known as Coupled Inquiry; linking these other instances together (Dunkhase, 2000). In this case, the teacher begins by utilizing a Guided Inquiry approach by posing a question to get started with the process, followed by further allowing students to come up with their own questions and ideas. In this manner, an Open approach is enabled, letting
students put together student-generated questions, thus enabling critical thinking and analytical skills as well (Martin-Hansen, 2002).

A fourth type of Inquiry approach, known as Structured Inquiry, creates an environment where the students are mainly directed by the teacher in following prescription or recipe-like lessons where they are limited mainly to directions. This Inquiry approach “typically results in a cookbook lesson in which students follow teacher directions to come up with a specific end point or product” (Martin-Hansen, 2002, p. 37). This method, the farthest from true Inquiry, focuses more on prescribed templates than on student centered learning. Researchers argue that more genuine student thinking occurs when the teacher allows students to make choices and decisions in science investigations (Clough & Clark, 1994).

Teachers’ Beliefs about Inquiry

Past investigations have suggested that “decisions people make and their associated actions directly result from their beliefs. Hence, the beliefs that teachers hold concerning the teaching of science as inquiry are at the core of educational change” (Smolleck et al., 2008, p. 295). Teachers’ beliefs about science inquiry not only impact whether they adopt inquiry in their practice or not, but also the types of inquiry they use. Studies have indicated that many teachers view inquiry instructional practices as mere objective and rigid processes, without any room for student internalization (Brown & Melear, 2006; Wallace & Kang, 2004).

Wallace and Kang (2004) concluded that school culture, teachers’ individual practices and their beliefs have an impact in how teachers employ or understand the
inquiry process. Participants in their study demonstrated genuine mastery in their understandings of what inquiry involved. Teachers in this study believed science inquiry could only involve their students in scientific concept-building or development of problem-solving skills. Barrow et al., (2001) proposed that teachers’ perceptions of Inquiry-based teaching were divided; some teachers thought of Inquiry as different isolated concepts, others viewed it as a convergence of practices. In most cases, teachers held non-student-centered views with regards to inquiry (Brown et al., 2006) or had some understanding of inquiry but lacked a complete picture of inquiry as described by the National Science Education Standards (Brown et al., 2006, Wallace et al., 2004). Several teachers seem to adopt only one aspect of inquiry (Wallace et al., 2004) such as group work, learning by discovery or sole science experimentation (Wallace et al., 2004) for instance referring to just asking a question as an opening lesson activity or having a lab activity with no analysis to follow their experimentation process.

In many cases, teachers’ lack of understanding of inquiry has been attributed to the nature of their professional development opportunities (Baird et al., 1989; Barrow et al., 2001). Not only are more professional development opportunities needed, but they also need to be differentiated to address the various perceived needs of teachers, rather than a one size fits all approach.

Teachers’ Inquiry Practices

Studies have indicated that many teachers do not employ inquiry instructional practices in their classrooms (Brown & Melear, 2006; Wallace & Kang, 2004). In a study of secondary teachers in Missouri, Barrow et al. (2001) found that 98% of teachers in a
rural region reported using lecturing as the most frequent method of instruction. In this same study, 57% of teachers indicated they did not use any inquiry teaching strategies at all. In a similar study by Baird and Rowsey (1989), 62% of respondents indicated they utilized inquiry teaching strategies in their science teaching. As mentioned earlier, whenever teachers report inquiry use, they seem to adopt only one aspect of inquiry such as group work or learning by discovery (Wallace et al., 2004). For instance, teachers may ask a question as an opening to lesson activities or labs with no follow-up, data analysis, or conclusion.

Barriers to Inquiry-Based Science

Several barriers to the use of inquiry-based science teaching have been identified in the literature, including misunderstandings of the inquiry process, low quality professional development, poor funding, class size and inadequate facilities. Additionally, teachers today still “continue to struggle in enacting classroom-based science inquiry due to lack of support, time [and] resources” (Kim et al., 2007, p.14).

Teachers’ accurate understanding of the inquiry process has been acclaimed as the main barrier to inquiry instruction. Conversely, while the teachers in Brown et al.’s (2006) study had a good understanding of the inquiry process, they recognized their limitations in being able to implement the process in their lessons. The teachers attributed their limitation to a lack of confidence in mastery of the inquiry process and differences in what they thought would be right ways of practicing inquiry in the classroom. In a study that rated teachers’ beliefs about inquiry, researchers found no significant change in teachers’ beliefs about inquiry after exposing them to several inquiry seminars (Harwood,
Hansen & Lotter, 2006). Even after extensive professional development preparation for Inquiry, teachers in Hansen et al.’s study were not able to display a mastery or confidence on inquiry.

Inquiry-based teaching “asks teachers to change their understandings through active learning experiences that are much different than the way they initially learned much of what they already know” (Johnson, 2006, p. 151). Sometimes this change in understanding can be limited by external factors such as large class sizes, translating into potentially ineffective inquiry experiences (Mchemer, et al.; Silverthorn et al. 2006). Other teachers are forced to learn to cope rather than effectively teach with an Inquiry-based approach. Johnson (2006) concluded that experienced teachers are rarely able to step out of traditional ways of teaching, whereas younger teachers are unable to relate to the versatility of the inquiry process, where it can be utilized to various degrees.

Johnson’s (2006) findings suggest that teachers experience different types of barriers to implementing inquiry at different stages of their careers.

Barrow et al. (2001) identified funding as the greatest perceived need or barrier to the use of Inquiry-based instruction. Chao et al. (1995) suggested that rural schools are usually less than adequately supplied and staffed for science instruction. Over 46% of their rural teacher participants indicated a high rate of dissatisfaction with equipment and supplies and a high number of them did not utilize additional resources to compliment science inquiry approaches in their practice. This same study concluded that “most rural schools lack both the population and taxable property base to generate the educational funding needed by today’s standards” (Chao et al., 1995, p.22).
In many cases, lack of funding results in inadequate science classroom facilities (Baird et al., 1994; Barrow et al., 2001 and Chao et al., 1995). “Inadequate laboratory facilities were also a frequent problem noted by 27.9% of respondents” (Barrow et al., 2001, p. 16) in a Missouri schools study. Only 60% of science teachers indicated they organized a science laboratory activity for their students (Baird et al., 1989). This could imply that a great majority of teachers in this study either did not have the necessary physical tools to conduct science inquiry activities or were unclear about what inquiry teaching involves.

Time has been identified as another barrier to the implementation of inquiry in instructional practices by several studies (Hardwood et al., 2006; Kim et al., 2007; Mchemer & Crawford, 2007; Williams et al., 2004). Many teachers attest time as being a hindrance to their use of inquiry because of instructional time (class period) provided by their schools or insufficient preparation period time (Kim et al, 2007). Inquiry, as a process, will undoubtedly require preparation and adequate support from both school administrations and teachers as well (Wallace et al., 2004) since “designing [and implementing] active learning events can be time-intensive on already overloaded faculty schedules” (Mchemer et al., 2007, p.11).

Research and Instruments

Most of the studies reviewed relied on survey designs to investigate teachers’ beliefs about inquiry and their inquiry practice. One of the most notable and utilized tool for assessing science teachers’ perceptions and inquiry practices has been the Science Teacher Inventory of Needs (STIN) developed by Zurub et al. (1983). The original STIN
contained 76 different items organized into seven categories: objectives for science instruction, evaluation of learners, science instruction planning, science instruction delivery, science instruction management, facilities and equipment, and personal competence as a science teacher (Baird et al., 1989).

Throughout the years, other investigators have utilized the STIN survey tool as a starting point or template in order to adapt and measure other aspects related to science instruction, labs and facilities. Wood et al. (2006) utilized a variation of the STIN and were able to establish a correlation between school environment and science instruction in rural schools.

Barrow et al. (2001) also utilized a variation of the STIN survey in order to investigate the needs of rural secondary science teachers in Missouri with positive validation outcomes. Smolleck et al. (2008) used a developmental process involving thirteen steps to validate a survey tool to assess teaching science as Inquiry (TSI) methods. The survey evolved into a STIN like survey questionnaire (Smolleck et al, 2008).
CHAPTER THREE: METHODOLOGY

The purpose of this study was to examine and describe the status of Inquiry-based Science instruction in Southeastern Ohio public High Schools.

The specific research questions were:

1. What are teachers’ beliefs and perceptions of Inquiry-based science teaching and learning?
2. To what extent do teachers in rural schools rely on Inquiry-based strategies for teaching science?
3. What factors (e.g. sample demographic variables, school designation, OGT Science graduation scores, facilities, beliefs etc.) influence teachers’ use of Inquiry-based strategies for teaching science in rural settings?

Research Design and Instrument

This survey study aimed to investigate Southeastern Ohio high school science teachers’ perceptions of inquiry, how frequently they used the strategy for instruction, and any barriers that may impact their decisions to use inquiry. The study relied on the “Science Instruction and Facilities Survey” [See appendix A] which was developed and adapted specifically for the study using items and prompts from existing surveys (Baird et al., 1994; Baird & Rowsey, 1989; Barrow et al., 2001; Chao et al., 1995; Wood et al., 2006; Smolleck & Yoder, 2008; Zurub et al., 1983). Relevant items from the validated surveys of the Science Teachers’ Inventory of Needs (STIN) © (Wood et al., 2006) and the Science Teacher Survey© (Zurub et al., 1983) were consulted to inform the
development of the “Science Instruction & Facilities Survey” (SIFS) survey used in this study.

The SIFS consisted of four different sections: demographics, teaching facilities, teachers’ practices, and teachers’ beliefs about inquiry. The demographics section (questions 1-14) asked about teachers’ attained education levels, gender, years of teaching experience, school designation, school’s demographic composition and their schools’ academic standing (see Appendix A).

The “facilities” section (items 15-19) in the survey probed the adequacy of science teaching facilities, the types of rooms at teachers’ disposal and how frequently they used them, and the presence of other resources that may influence teachers’ practice.

The third section of the survey focused on teachers’ beliefs about science teaching and learning (items 20-23). Lastly a fourth survey section probed the types of practices science teachers chose to adopt in their classrooms (items 24-30) and the factors they considered as barriers to inquiry (items 18-20, 23, 29).

Six of the survey items were in an open-ended format, allowing respondents to freely express their opinion and/or views on certain issues. These questions addressed teachers’ beliefs about inquiry-based instruction (questions 22-24, 26) and the strengths of their practices and/or facilities (questions 14-16). The remaining 24 survey items were set up in multiple selection lists (demographics section) and a rating scale format similar to the Likert scale (teachers’ practices). {See Appendix A}

In addition to consulting items from the Science Teachers’ Inventory of Needs (STIN) © (Wood et al., 2006) and the Science Teacher Survey© (Zurub et al., 1983),
SIFS survey items were constructed by consulting findings of research studies with a similar focus (Baird et al., 1994; Baird et al., 1989; Barrow et al., 2001; Chao et al., 1995). The SIFS development followed a process similar to Zurub et al.’s (1983): (1) a synthesis of statements, (2) validation of the content, (3) collection of information on previous similar studies and (4) the construction of the survey based on these initial steps. The survey was then piloted to determine areas of opportunity, items that could be altered, added, deleted or clarified (Zurub et al., 1983). The survey was then revised prior to data collection similar to Wood et al. (2006). To ensure validity the SIFS was piloted during the summer of 2009 with a group of secondary science teachers and science educators. The SIFS was then revised to reflect the feedback and commentary of the pilot study participants. Feedback focused mainly on rephrasing of some survey questions and several suggestions for formatting.

Sample

Appalachian Ohio includes over a third of all the territorial expansion of the state and encompasses 29 total counties (Ohio Department of Development, 2007). The sample for this study is Southeast Ohio, which is included within the Appalachian counties of the state. The Southeastern portion of Ohio alone comprises 44% of all Appalachian counties in the state, which include: Athens, Gallia, Fairfield, Hocking, Jackson, Lawrence, Meigs, Monroe, Morgan, Noble, Perry, Vinton and Washington Counties. (See fig 1 below)
In 2000 Appalachian Ohio had an estimated population of 1,455,313 with an estimated per capita income of $20,516 and a high school graduation rate of 84.1% a year (Ohio Department of Development, 2003). These vitals make the study of science instructional practices in Southeastern Ohio a desirable and fascinating investigation.

In 2007 a total of 579 public schools existed in Appalachian Ohio where a total of 15,307 teachers were employed (Ohio Department of Development, 2007). Of these, 489 teachers were identified as science teachers in Southeastern Ohio. These teachers composed the sample for the study.
The SIFS was emailed to the 489 science teachers in southeastern Ohio through www.surveymonkey.com. Email addresses were obtained through an extensive search of school websites and staff directories from schools by the researcher. Website information not posted online was retrieved through phone calls to those particular schools. Recipients were given a two week period to access the online address link to the Science Instruction and Facilities Survey (SIFS). The SIFS was made available to respondents from October 18th and accessible through October 30th 2009. Twenty-nine emails were returned as undeliverable due to either inactive or invalid email addresses. In addition, 14 of the emailed teachers indicated they did not wish to participate and opted out from the study after a second email was sent to participants to remind or thank their participation. In addition, 52 Wal-Mart® stores $5.00 gift cards were mailed to participants who completely responded to the survey. Funding for the purchase and mailing of these gift cards was made possible by the Ohio University College of Education research fund. Only 68 of the 460 remaining teachers within the sample accessed and completed the survey. The total response rate for this study was calculated as 14.7%.

Data Collection

Approval for Human Subjects Research by the Ohio University’s Institutional Review Board (IRB) was obtained prior to data collection and any communication with the study sample (see Appendix B). The Science Instruction & Facilities survey was posted on a web link through www.surveymonkey.com. It was electronically submitted via email to science teachers and instructors from public high schools in Southeastern Ohio in order to reduce costs and expenses. The survey was designed and expected to
take approximately 15-20 minutes for participants to complete. An email was sent to school principals in order to pre-communicate the study’s goals and expectations and also to recruit principals’ support at their schools (see Appendix C). An email communication was also sent to the sample one week prior to the survey in order to explain to respondents the purpose of the study and inform them that they will be receiving a survey to complete by email. In this manner the researcher was able to establish a relationship with both school principals and participants preceding the survey. Participants were assured of the privacy and confidentiality of their responses throughout the whole process. Participants were also informed of how the survey posed no threats or risks to them and how information was confidentially protected for their benefit at all times during the process. An informed consent statement, as established by IRB rules and regulations was embedded within the introduction email, educating participants about the informed consent process, what is involved in it and how by completing the survey, they agreed to its terms and conditions (See Appendix D).

Respondents were given a two-week period to review and submit their survey responses online. A follow-up email was sent one week after the initial deployment of the survey in order to thank them for completing and/or remind them to complete the survey. Communication with participants began on September 25th and ended October 30th of 2009. The survey was made available to participants on October 18th, 2009 and remained accessible until October 30th.
Data Analysis

Sixty-eight survey responses were received from a total of 460 successfully sent emails. The response rate for this study was calculated as 14.7%. Quantitative data from the surveys were analyzed using descriptive and inferential analyses. With descriptive statistics, generalizations are limited to a particular group and/or sample, where one simply describes what is or what the data shows (Best et al., 2003). Inferential statistics, on the other hand involves reaching conclusions that extend beyond the immediate data alone (Best et al., 2003). Data in the form of responses to open-ended questions were coded and categories generated.

The survey targeted four different aspects: demographics, teaching facilities and other barriers to inquiry, teachers’ practices, and teachers’ beliefs about inquiry. In order to analyze and establish inferences from the surveying process, data were organized and processed using Microsoft Excel®, a spreadsheet program; and SPSS®, a statistical analysis program. This allowed for data to be organized, charted and graphed during the analysis process. The organized data was subjected to various statistical analysis tests by research question and observed relationships between responses (Best et al., 2003).

In order to identify relationships within different groups such as gender, in-service years or frequency usage of inquiry by teachers, various statistical tests were utilized such as Correlations, Cross tabulations and ANOVAs (see Appendix C). A graphic representation chart (See Appendix C) concisely represents how the survey was analyzed and how it responded to the research questions considered in this study.
Collected data was analyzed by research question and by observed relationships between responses.

**Demographic Information**

Survey questions 1-12 surveyed participants’ demographic information as well as information describing the schools in which they worked. Frequency distributions, means, and modes were calculated and used to describe participants’ demographics, including gender, number of years teaching science, number of years teaching science at their current school, and highest degree attained, licensure type, licensure area, and grade level currently taught. Responses to open-ended questions were grouped together, tallied, and frequencies calculated. This content analysis was used to describe participants’ undergraduate majors, graduate majors, past professional development, and school demographics such as the percentage of students eligible for the free/reduced lunch program, ethnic composition, OGT Science passing rate, and state designation. School demographics were further described using means and standard deviations calculated in Excel.

**Research Question 1**

The first research question was concerned with teachers’ beliefs and perceptions of Inquiry-based science experiences. Responses to survey items 20a, 20b, 21, 22, 23, and 24 were analyzed in response to research question 1. Responses to items 20b, 21, and 23 were examined for trends or patterns. Emerging categories were identified and collapsed as the need arose. Frequency distributions of responses within each category were calculated.
Frequency distributions for responses to question 20a were calculated in Excel. To determine if a relationship existed between teachers' beliefs about the extent inquiry advances student learning (item 20) and gender, master's degrees (item 3), licensure type (item 5) and licensure area (item 6), a *t-Test* was run in SPSS. A Correlation was run using SPSS in order to establish a relationship between inquiry teaching student learning advancement and the type of licensure teachers held.

The researcher also wanted to examine teachers' beliefs about inquiry advancing student learning (item 20) and grade levels taught (item 8), the approximate percentage of eligible students for the free/reduced program (item 9) and schools' ethnic composition by running a Correlation (*Pearson*).

Finally, the researcher also wanted to establish any differences between teachers' belief of inquiry advancing science learning (item 20) and their reported passing rates on the OGT Science (item 11) through a Comparison of Means using SPSS. A frequency distribution was calculated for teachers who did not know what the different types of inquiry were (question 24).

Items 20a and 20b (open-ended) asked teachers to indicate the extent to which they believed Inquiry-based instruction advanced student learning. A tally was created based on their responses, then percentages quantified and graphically represented through Excel. For item 20b, which asked participants to indicate why they thought Inquiry-based instruction advanced learning, a content analysis was done by creating a list based on responses and then categories generated.
Research Question 2

Research question number two referred to the extent which teachers relied on inquiry-based strategies to teach science. Survey items 19, 24, 25, 26, 27, and 28 were analyzed in order to answer this question.

Items 24 and 25 asked participants to indicate which and how often they utilized different inquiry methods. Item 24 was organized by category and frequency responses distributions were calculated for items 25 and 26 using Excel.

The researchers also wanted to find out if teachers’ report on their actual inquiry practice varied by school designation. In the State of Ohio, the overall yearly achievement of schools is quantified by how effectively they can meet the goals of 30 different performance indicators, a performance index, adequate academic yearly progress and a value added measure (Ohio Department of Education, 2008). These measures of effectiveness can then categorize every school in Ohio as “Excellent with Distinction”, “Excellent”, “Effective”, in “Continuous Improvement”, “Academic Watch” or “Academic Emergency” depending on how their yearly achievement has been rated (Ohio Department of Education, 2008).

The researcher then was interested in examining if school state designation and teachers reported use of inquiry had any significant relationship to the study, assuming that inquiry was to be done more than just once a week based on schools with “Excellent” and “Excellent with Distinction” designations, as previously indicated by participants in survey item 12. A one way ANOVA test was performed in SPSS between schools’ state designations and teachers’ reported use of Inquiry.
Survey item 26 asked teachers to indicate how often they actually relied on inquiry in their classrooms. A chart was created based on the frequency of items selected by participants and percentages were tabulated utilizing Excel in order to graphically represent findings.

The researcher wanted to know if there were any relationships between teachers’ actual reported usage of inquiry (item 26) and their licensure (item 5). A Correlation was run in SPSS to establish relationships between kind of license and actual usage of inquiry. To test the role gender played in the actual use of inquiry a t-Test was performed using SPSS as well.

The researcher also wanted to observe relationships between teachers’ use of inquiry and grade level taught (item 8), reduced lunch program participants (item 9) and schools’ reported OGT Science scores (item 11). To test use of inquiry and grade level a Correlation was done in SPSS. For students under the free/reduced lunch program and use of inquiry a Comparison of Means was calculated using SPSS as well. A Correlation was also run to observe connections between OGT Science scores and reported use of inquiry.

Since item 22 had asked teachers to indicate how often they believed inquiry should be used in the science classroom, the researchers wanted to know what, if any, connection existed between their belief and actual use of inquiry. A cross tabulation test (X2) was done in SPSS between survey items 22 and 26. Mean distributions were also calculated using Excel in order to group results and graph a combined graph to highlight these differences.
Research Question 3

Research question number three asked about factors or barriers that influence teachers’ use of inquiry-based strategies for teaching science in rural setting. Responses to survey items 15, 16, 17, 18, 23, 29, and 30 were analyzed to answer this question.

Survey items 15-16 asked participants to describe the science teaching facilities available at their schools and the ones they actually utilized for teaching. Open-ended entries on these items were examined through a content analysis based on emerging themes identified throughout responses. These were listed and tallied as similar themes arose within responses.

Item 17, which asked teachers to indicate the kinds of teaching resources they used for teaching science, was analyzed by organizing responses into a list and classifying them according to emerging themes.

Items 18 and 18b asked participants to rate the adequacy of their science facilities that supported science teaching. For item 18 a descriptive analysis was done and another tally created based on responses. Item 18b, an open ended item was organized by creating a tally of responses and generating categories according to emerging themes.

Item 23 asked teachers to identify the single biggest obstacle which could prevent them from using inquiry in their practice. Open ended responses were organized through a list and categories based on emerged themes quantified through Excel.

Item 29 asked teachers to rate the extent to which different factors negatively affected their ability to deliver inquiry instruction. To verify if any relationship existed between the actual use of inquiry reported by teachers and years of teaching, a cross
tabulation ($X^2$) analysis was conducted. To observe if gender had any relationship with the report on inquiry use (item 26) and their licensure (item 5), a Correlation was run in SPSS.

Survey item 30, an open-ended question, asked teachers to indicate the kinds of community resources available to them at their schools. Entries were listed in an Excel spreadsheet and subdivided by emerging categories. A content analysis was then performed to process results.

The researcher wanted to examine if any relationship existed between teachers’ number of years in service (item 1b) and reported negative factors towards use of inquiry (item 29) by running a Pearson Correlation in SPSS.
CHAPTER FOUR: RESULTS AND IMPLICATIONS OF THE STUDY

The purpose of this study was to examine and describe the status of Inquiry-based science instruction in Southeastern Ohio public high schools. The chapter has been divided into three major sections, including: a presentation of the findings, an ample discussion of these findings by research question as they relate to the reviewed literature and lastly, final considerations about the project and further recommendations for future studies.

Demographics

A total of 68 teachers responded to the survey. Fifty-four percent of respondents were identified as male compared to 46% female. Participating teachers held undergraduate degrees in Biology (46%), Chemistry (5%) and Physics (12%). The remaining teachers had degrees in education (25%) and natural/earth science (12%). Sixty-five percent of participants held Master’s degrees in various fields in education and/or science such as Environmental Studies, Administration and Curriculum & Instruction. No participants had completed a doctoral degree.

Most participants (98%) were licensed to teach, as 70% had a Professional licensure, 17% Provisional ones, and 3% had an Alternative Educator’s License (AEL). Participants’ areas of licensure consisted of biological/life sciences (48%), physics (26%), (Chemistry (37%), Earth & Space Science (19%) and Environmental Science (17%).

Teachers in this study had been in service an average of 13.3 years, with a 9.5 year average for teaching science at their particular/current schools. Seventy eight
percent of participants taught 11th grade, 75.8% 12th grade, 64% taught 10th grade, and 52% taught 9th grade. Teachers indicated participation in various professional development programs over the last five years. A great number of teachers (65%) indicated having participated in professional development programs focused on assessment, 58% on differentiated instruction, and 47% on inquiry related courses. Additionally, many teachers also reported participation in technology, computer training, administration and team building seminars.

Teachers indicated working in schools where, on average, 44% of students were eligible for free or reduced lunch programs. Students at these schools were predominantly White (94%). An average of 5% of students was Black and the remaining 1% was Hispanic, Asian, or from other unidentified minorities. Ohio Graduation Test (OGT) average reported passing rates for science was 76% compared to the ODE (2007) reported average of 83% for the Southeastern Ohio region and 76% for the State. Fifty six percent of schools in this study were designated as Excellent with Distinction or Excellent, compared to the 34% reported statewide average (ODE, 2007). Comparable with State reports, 28% of schools were reported Effective, and 16% in Continuous Improvement. The following table compares participants’ school report card data with published State of Ohio and Southeastern Ohio school reports. (See table 1 below)
Table 1 - School Demographic Comparisons

<table>
<thead>
<tr>
<th>School Designation</th>
<th>OGT Science</th>
<th>Free/Reduced Lunch</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE Ohio: Teachers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report Excellent W/Dis</td>
<td>5%</td>
<td>76%</td>
<td>44%</td>
</tr>
<tr>
<td>Excellent Effective</td>
<td>51%</td>
<td></td>
<td>Black 5%</td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>28%</td>
<td></td>
<td>Other 1%</td>
</tr>
<tr>
<td>Other</td>
<td>16%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE Ohio</td>
<td>--</td>
<td>83%</td>
<td>35%</td>
</tr>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent W/Dis</td>
<td>7%</td>
<td>76%</td>
<td>26%</td>
</tr>
<tr>
<td>Excellent Effective</td>
<td>34%</td>
<td></td>
<td>Black 15%</td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>27%</td>
<td></td>
<td>Other 9%</td>
</tr>
<tr>
<td>Other</td>
<td>15%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. (--) no data available


Beliefs about Inquiry

The study’s survey asked teachers to define what inquiry-based science meant to them in their own words. Although they each provided individual open-ended entries, three major themes were categorized according to participants’ answers and their emerging subjects. A total of 28% teachers associated inquiry-based learning to hands-on or discovery learning strategies such as lab activities or case study scenarios for students to engage in. Ten percent of teachers alluded to inquiry as a form of guided learning inclined towards demonstration techniques, such as audiovisual presentations on new science topics or manipulation of instruments, including microscopes and science
probeware. Teachers (30%) singled out Inquiry-based learning as activities where students asked questions, worked in groups and/or defined a problem. Mentioned group activities included allowing students to choose an investigation method/topic, followed by work group interactive feedback provided by the teacher. Particularly, one teacher commented on Inquiry based teaching as being a: “strategy that helps students ask questions and find the answers to those questions by experimentation and other hands-on activities.” Another teacher commented that inquiry: “is a science process which allows for the use of critical thinking, promotes group working and the use of problem solving and analytical thinking skills”.

Teachers identified how frequently they believed inquiry-based teaching should be used in the classroom (survey item 22). They indicated inquiry-based teaching should be used on a daily basis (30%), 2-3 times/week (30%) or on a weekly basis (19%). Seventeen percent of teachers indicated inquiry was to be used monthly and 4% it should never be used. Teachers indicated they believed Inquiry-based instruction advanced student learning to a major extent (50%). Thirty-one percent indicated it did to a moderate extent and 13% to a minor extent. Five percent of teachers indicated they believed inquiry did not advance student learning at all. (See fig 2 below)
Through open-ended entries teachers justified their belief on how inquiry-based instruction advances student learning. Based on major emerging themes, 24% of participants indicated inquiry advanced student learning because it allowed students to learn by doing, discovering and by having a hands-on approach. Other teachers (6%) indicated it allowed students to formulate questions, observe or work with real-life problems. However, 13% expressed having concerns with inquiry because some students could struggle with scientific ideas, proper scientific vocabulary or need of a better science background in order to tackle science effectively and make relevant concept connections. One teacher in particular reported neither using nor exactly knowing what inquiry really meant. Another teacher commented it was “hard to ask [students] questions when one doesn't have a remote idea of the possibilities or the vocabulary to describe them”.

Figure 2 - Belief of inquiry in learning.
Reported Inquiry Practices

Teachers in this study described the approach they typically used for teaching science in their classrooms. Based on open-ended responses, several categories were drawn out from emerging themes. A total of 37% of teachers indicated using the lecture method throughout their science instruction process, such as dictating concept definitions. Some teachers referred to their approach as “very close to traditional lecture” or “simply text-driven lecture and demonstrations” in their practice.

Other teachers (22%) reported doing laboratory activities as part of their instruction or mentioned having hands-on activities with their students, including instrument manipulation and tangible demonstrations.

Twenty-seven percent of teachers alluded to using “some form of inquiry” throughout their teaching, such as allowing students to formulate their own questions or letting them design their own experiments. Eight percent of teachers indicated having demonstrations done before their class and another similar 8% reported having students engage in discussions in their classrooms. Discussions included case study debates or conversations. Some teachers indicated they had students participate in “peer teaching before moving on with inquiry” or that “students need[ed] to interact with the content and deepen their understanding” through discussions.

Teachers also listed resources, equipment and materials regularly used throughout their science instruction activities. Based on open-ended responses, the following categories were drawn from teachers’ entries: a total of 67% of teachers reported utilizing technology in the form of computers, simulations and projectors, Smartboards®, DVD’s,
digital data collection probes such as PASCO® probes and related materials in their instruction. Other teachers stated utilizing dissection specimens (5%) with their laboratory experiments or microscopes (14%). Eleven percent of teachers reported using chemicals/reagents for their experiments in science and 9% reported using or letting students manipulate laboratory utensils or glassware, such as beakers. Other teachers (14%) reported utilizing textbooks and manuals for instruction practices.

When asked about their actual use of inquiry, 14.3% of teachers reported using inquiry daily as an instructional practice; 22.4% reported that they used it 2-3 times/week and 33% on a weekly basis. Twenty-two percent of the teachers reported using inquiry strategies with a monthly frequency and 8% indicated never using it. (See fig 3 below)

![Teachers' Reported Usage of Inquiry Teaching (Belief vs. Reported Use)](image_url)

Figure 3 - *Belief vs. reported use of inquiry.*
Teachers reported using various types of inquiry in their practice. Sixty-six percent of teachers indicated that they used guided inquiry, 46% open inquiry, 10% coupled inquiry, and 50% structured inquiry. Other teachers (14%) indicated not knowing what any of the types of inquiry were. Fifty percent of teachers reported using structured forms of inquiry with a weekly frequency. A total of 41% of teachers indicated using guided inquiry on a weekly basis. A noticeable amount of teachers reported never using Coupled Inquiry (77%, see fig. 5), whereas only 10% had indicated using it as a practice in the classroom (see fig.4). A strong possibility in the reason for this observation could be attributed to teachers not knowing what Coupled Inquiry involves in the first place.

![Graph of Inquiry Methods Reported in Science Classrooms](image)

**Figure 4** - *Inquiry methods reported by teachers.*
When asked about the kinds of science activities they involved students in, teachers reported using activities that promoted discussion and group work integration (fig. 6 below) on a monthly basis. However, 60% (see fig. 6) of teachers indicated never conducting activities which deepened science understanding with their students. Teachers also reported never involving their students in journal reflection activities (50%) nor bringing or using community resources in their practice (38%). [see fig. 7]

Similarly, when rating activities where investigations, experimentation, technology, observation and questioning were encouraged, respondents relied on them more on a monthly-to-weekly frequency basis. On average, 30% of teachers reported using these types of activities on a weekly basis.
Figure 6 - Student involvement in science activities.

Figure 7 - Student involvement in science activities (2).
Factors Impacting Teachers’ Use of Inquiry

Teachers (86%) indicated having available teaching facilities equipped with sinks, burners, gas and desks. Thirty-seven percent indicated having classrooms with desks and 58% classrooms with group-work tables available for use at their schools. Teachers (64%) reported actually using classrooms with sinks, burners, gas and desks. Forty-four percent indicated teaching in classrooms equipped with tables and 24% in classrooms with desks. A total of 7% of teachers pointed out teaching in fully equipped traditional laboratory facilities. (See fig 8 below)

![Available vs. Reported Used Facilities for Science Teaching](chart)

**Figure 8 - Science facilities: Reported used vs. available.**

Teachers also rated the adequacy of their teaching facilities. Thirty-one percent reported their teaching facilities were adequate to a major extent. Fifty-nine percent indicated facilities were adequate to a moderate extent, 3.5% to a minor extent and 5.3%
expressed that their facilities were not adequate. Through open-ended responses, more than half of teachers indicated they had no problems with the adequacy of their science instruction facilities by indicating they were either “undergoing classroom renovations” or “awaiting approvals to start planning renovation”. Other teachers indicated room size as being small but being “able to manage by making the most out of their available space”. Other teachers (52%) acknowledged how supportive their school administrations were towards science programs and facilities by indicating support was provided in the form of effective channels of communication available between faculty and administration. Twenty-four percent of participants indicated funding or budget issues as being a problem, as some indicated funding was either minimal or getting cut towards other academic programs. Nine percent of teachers indicated technology was inadequate in their classrooms by being either outdated or non-existent in their facilities. Teachers specifically mentioned lack of sufficient computers and projectors in their classrooms. Fourteen percent of teachers pointed out size, space and room conditions as inadequate in their schools. One teacher commented exhaust fans available at their laboratory were not for venting chemical vapors. Some teachers commented on their available facilities, expressing that “labs [were] there… but rarely functional” or that they were “available but rarely used”. A cross tabulation test between school designation and quality of facilities suggested no statistically significant relationship $\chi^2(12, N = 52) p = 0.07.$
Figure 9 - Adequacy of teaching facilities.

Teachers reported the following as obstacles that prevented them from implementing inquiry-based science teaching:

- *Time* (46%) - Teachers mentioned both preparation and available period duration being reduced in some schools.
- *Equipment & Facilities* (22%) were an issue– Some teachers reported lab equipment missing or outdated in their schools, and deplorable room conditions.
- *Training in content areas* as an obstacle- 10%
- *Administrative support* (10%)

Teachers were then asked to rate the extent to which certain factors negatively impacted their ability to deliver inquiry-based instruction (survey item 29). Teachers (56%) rated time as a major factor, 48% rated class size as a moderate factor, and 33% rated existing equipment, room size and layout as minor factors. More than 50% of
teachers reported conditions of room, mastery of subject matter, community resources, and school administration/support had no negative impact in their teaching. (See fig 10 below).

Figure 10 - *Negative impact of ability to deliver inquiry.*

Additional factors that may impact teachers’ inquiry beliefs and practices were investigated. These factors included teachers’ gender, licensure area and type, years of teaching experience, grade level taught, school designation, percentage of students under the free/reduce lunch program, and OGT Science scores.

A one way analysis of variance (ANOVA) test was used to investigate the relationship between teachers’ belief about inquiry advancing student learning and licensure type, licensure content area, and grade level taught. No significant relationship was found between belief of inquiry advancing student learning and type of license, $F(4,$
63) = 2.66, \( p = .40 \). No significant relationship was found between teachers' beliefs of inquiry advancing student learning and license content area, where \( F(4, 63) = 0.752, p = .56 \). No significant relationship was observed between teachers' belief of inquiry advancing student learning and grade level, where \( F(4, 61) = 0.743, p = .567 \). These tests suggested teachers’ beliefs on the extent inquiry advanced student learning were held independently of their licensure, content area or grade level taught.

An ANOVA test on school designation and teachers’ report of the extent they used inquiry indicated no significant difference between how often teachers relied on inquiry and school designation, where \( F(3, 59) = 2.66, p = .167 \).

A Chi-Square test \( \chi^2(16, N = 58) = 0.87, p = .05 \), suggested a significant gap between the extent teachers believed inquiry should be used in the classroom and their report of how often they used it.

The study’s sample consisted of a fairly experienced group of teachers (\( M=13.30, SD=3.23 \)) which, more than likely were veterans in their subject and/or content areas. A Cross tabulation \( (X^2) \) analysis was conducted between the type of licensure teachers held and the amount of inquiry they practiced, in order to identify any relationship between the two. A Correlation between use of inquiry and type of licensure showed no significant relationship, where \( p=.90 \) (44). A Cross tabulation \( (X^2) \) test was also performed between the amount of years teachers had taught at their particular schools and the amount of inquiry they practiced, in order to identify any relationship between the two. A Correlation on these calculated no significant difference between years of teaching and actual inquiry practice, where \( \chi^2(1, N = 48) = 0.47, p = .46 \). The researcher
later then noted that as the amount of in-service years of science teaching increased, the less likely teachers were to include some inquiry-oriented activities in their practice with regularity.

To test differences in the means of use of inquiry and gender a *t*-Test was conducted. There was no significant effect for gender, where *t*(46) = 2.21, *p* > .001. This test suggested participant’s responses to the reported frequency of inquiry usage had no relationship with their gender.

To investigate the relationship between teachers’ reported use of inquiry and grade level taught, students under the free/reduced lunch program and OGT Science scores, correlations were used. A Correlation suggested no significance existed between use of inquiry and grade level, where *r*(44) = .45, *p* = 0.77. A cross tabulation between use of inquiry and OGT Science scores assumed no relationship was present, where *χ*²(3, *N* = 42) = 0.90, *p* = .73.

**Discussion and Implications**

The purpose of this study was to examine and describe the status of Inquiry-based science instruction in Southeastern Ohio public high schools. Conclusions from this study are important not only to report on the status of inquiry but also to rethink effective ways to which Inquiry-based teaching and learning can be better utilized by teachers. Findings from this project can establish a contrast between the status of inquiry in Southeastern Ohio, the rest of Appalachian Ohio and ultimately the rest of the state. These inequalities can, in turn, encourage further research and strengthen initiatives towards pre and in-service teacher preparation programs as well.
Teacher’s Beliefs and Perceptions on Inquiry Based Science

Understanding and considering what teachers believed about Inquiry-based teaching was fundamental in order to gain a better perspective on the status of science practices in Southeastern Ohio. A notable finding was to observe teachers indicated inquiry meant “hands-on-activities”, “discovery learning”, “asking questions” or “having student-led learning” with the most frequency. Most teachers appropriately singled out activities related to inquiry and different scenarios where they would use it in their teaching. Although most answers were consistent with instances that support inquiry learning, teachers’ answers did not necessarily acknowledge inquiry as a process. Most teachers described inquiry in terms of individual activities that are merely done with students and not necessarily with the purpose needed to provide inquiry activities appropriately relevant throughout the curriculum (Aldous, 2008). It was found, in particular, that teachers tended to rely more on isolated methods or activities towards inquiry but failed to properly relate to these activities with a purposefully thought meaning and reasoning for doing these.

Extent of Inquiry-Based Teaching Strategies by Teachers

The second research question in this study referred to the extent to which teachers in rural schools relied on Inquiry-based teaching strategies.

Several items in the SIFS were aimed at measuring teachers’ beliefs or perceptions of Inquiry based Science and their frequency of usage in the classroom. More than half of participants indicated they believed inquiry teaching advanced student learning. When rating teachers actual usage of Inquiry and compared with their belief,
several interesting differences were observed. Some teachers reported they believed inquiry should be used at least 2-3 times/week or on a daily basis. Nonetheless, when analyzing their actual reported usage a decrease was noted compared to their reported belief.

Conversely, the researcher noted the actual reported use of Inquiry by one third of participants on a weekly basis was considerably higher than their previously reported belief. A similar dynamic was also seen for teachers reporting inquiry as being done or used on a monthly basis when compared to their beliefs. It appears though teachers’ ideal belief for the use of inquiry mostly inclined towards being used daily if not on a 2-3-days/week basis; despite their actual reported practice suggesting inquiry being used more in a weekly (once-a-week) frequency. Overall, a steady (11%) gap difference was observed between teachers’ belief and reported use of inquiry. Findings from this study suggest that significant factors are present which widen the gap between belief and practice in the use of Inquiry-based teaching in the science classroom which include school funding, available materials, time and teacher preparation or confidence in their inquiry skills. A study presented in our literature review noted how Baird & Rowsey (1989) indicated a low percentage of their sample utilized inquiry strategies in their science teaching, noting how factors similar to this study’s acted as factors that widened the gap between belief and practice.

Teachers also indicated how available teaching time was of essence and could vehemently affect their science practices. One teacher commented that the “breadth of the content standards does not always allow adequate time for inquiry-based
instruction”. Another teacher indicated that “planning time, especially common time with colleagues, to develop new activities”. These voices resonate with other teachers’ in previous research studies, suggesting time is a powerful and significant factor in the use of inquiry as an instructional practice and teachers’ decision to use it (Kim et al., 2007).

Another part of this study addressed the different types of inquiry and asked teachers to identify which forms they utilized and with what frequency. Teachers then responded to the different types of Inquiry they employed in their classrooms and reported they used Structured and Guided forms the most. A total of 78% teachers indicated using Guided Inquiry with the most frequency. Alternatively, only 46% indicated using Open Inquiry, considered by some the truest form of Inquiry (Martin, 2002). Also known as “Full Inquiry”, Open Inquiry is unique in that its basis relies and begins with genuine questions students formulate and with groups they form in order to design and conduct their own experiments based on their original questions. An Open form of inquiry practice is a strong aspect in allowing the student to become the focus throughout the process and also allowing open room for observation, critical thinking and scientifically-oriented conclusions as noted by Colburn (2006) and Martin-Hansen (2002). One reason behind teachers not relying more on Open Inquiry strategies could be attributed to them not adopting other forms of science teaching strategies, other than the traditional lecture method. As noted in a previous study by Barrow et al., (2000) teachers tend to adopt habits of teaching which can result in practices that can allow them to control their environments. Teachers indicated not using Coupled Inquiry in their
practice. A strong possibility in the reason for this observation could be attributed to teachers not knowing what Coupled Inquiry involves in the first place.

Considering teachers reported practices of student involvement in activities that promoted discussion and group work integration, a tendency was observed towards having activities like these used just on a monthly basis by teachers. However, when it related to specific activities that fostered group work, hands-on activities or “doing inquiry activities”, few teachers (35% on average) indicated using them with weekly regularity.

Similarly, teachers report on activities where investigations, experimentation, technology, observation and questioning were encouraged, they reported relying on them more on a monthly-to-weekly frequency basis. Instances such as journal reflections and use of community resources were reported as used the least or never by teachers. These findings suggest that activities such as technology applications, experimentation and specific tasks were used less in instructional practices by respondents because of other factors which impacted their decisions such as available material and a lack of use of community resources as previously noted as reasons for teachers reporting relying less on inquiry practices. As seen earlier, whenever teachers reported inquiry use, they relied less on discussion oriented activities. Similarly to these findings, previous studies on inquiry practices adopted by teachers, researchers have noted that teachers tend to entrust their practice to methods which allow them controlled environments where students just follow instructions (Wallace et al., 2004).
Two separate survey questions asked participants to indicate the kinds of available facilities for science teaching at their schools and the kinds of facilities they actually used. There seemed to be a gap between reported available facilities and the ones being actually used to facilitate science learning. For instance, when asked about a classroom with sinks, burners, gas and desks, 86.4% of teachers indicated these facilities were available for their disposal but only 64.4% indicated utilizing them; a 20% significant gap. A similar but reduced gap was also found when asked about having and/or utilizing classrooms with desks vs. tables. Similar differences were also found in the use of classrooms with desks or tables. Certainly there exists a breach between available facilities and actual ones being used to teach science. This report could suggest that even though facilities were available for teachers’ usage, they could be underutilized because of a decrease in traditional science laboratory activities or deplorable facility conditions.

On the other hand, 60% of teachers had identified their science teaching facilities as being adequate to a moderate extent. This could suggest that the overall conditions of rooms available for science teaching were usable and acceptable in a moderate to major extent. These figures agree with findings in rural schools in the nation across the board as reported in the 2007 Status of Rural Education Report by the U.S. Department of Education. As Chaney and Lewis (2007) reported back then, 69% of rural schools had reported their science facilities supported the ability of the school to deliver science instruction in any major extent.
Factors That Influence Teacher’s use of Inquiry Strategies

A third research question considered in this study was the different factors which could influence teachers’ use of Inquiry-based strategies in rural communities.

Several factors can impact and utterly affect the outcomes of Inquiry-based instruction. Teachers were able to rate some of these factors ranging from “not affecting” them in any extent at all, to minor, moderate and major extents based on how intensely they though different factors could act as barriers towards the implementation of inquiry as an instructional practice. Teachers would moderately rate most factors but did not hesitate to single out time as one of the biggest obstacles for using inquiry due to its time consuming nature, perhaps. The most notable aspect on these factors was the issue of available time for inquiry. Teachers (56%) indicated time having a negative impact to a major extent in how they delivered inquiry instruction. Time was also a considerable hindrance to teachers in a previous study where teachers noted not having sufficient instructional nor preparation time (Kim et al, 2007).

Class size was also found to have a negative impact towards science instruction, where 48% of respondents indicated this as being an issue to a moderate extent. External factors such as large class sizes can utterly affect the quality of inquiry delivered to students as noted in past research (Mchemer, et al.; Silverthorn et al. 2006).

Additionally, an average of 58% teachers reported school support, subject matter, room conditions and community involvement as not having any effect at all on their delivery of Inquiry teaching.
Specifically, 59% of teachers indicated community involvement did not have any influence in their use of inquiry. Interestingly, when asked which kinds of community resources were available in supporting inquiry at their schools, 52% of teachers indicated they were not aware of any resources in their communities or that none existed at all. Commenting on the negative impact of teachers’ ability to deliver Inquiry instruction, the fact that teachers are not aware of community resources at hand is a compelling find. Again, if teachers are unaware of these opportunities, then any available community resources could very well play important roles in how communities impact science learning. Twelve percent of respondents alluded to inviting professional community members as resources to compliment their science lessons, but only 25% teachers indicated using local community industries or institutions as science resources.

Conclusions

Based on this study’s findings, the researcher noted that teachers’ beliefs and perceptions of Inquiry-based science were fundamental to this project. The study concluded many teachers properly mentioned good and relevant instances of inquiry in their teaching but were not on target in relating these practices to a holistic concept. All in all, inquiry was observed as being referred to activities or methods-to-follow on science instances rather than a process, orchestrated in a conscious effort to promote scientific literacy, critical thinking and analytical skills. Teachers were very knowledgeable about the concept and widely apt to teach utilizing inquiry as a process in their science teaching.
In previous studies on teachers’ beliefs about inquiry, similar outcomes have been noted. Wallace et al., (2004) concluded that while some teachers believed inquiry occurs when students were able to understand a scientific problem, others solely believed its purpose was to just develop problem-solving skills, failing to grasp inquiry as a convergence of practices tied to the inquiry process. This project then concluded that several factors which distort teachers beliefs about inquiry to isolated practices exist and need further studied in order to promote a superior understanding or inquiry that can ultimately translate into a relevant practice.

The researcher also considered the extent to which teachers relied on Inquiry-based strategies for teaching science in the Southeastern Ohio region. Findings suggest that although teachers believe inquiry should be utilized on a frequent basis in the classroom, their actual usage was significantly lower than their indicated belief. Teachers relied more on inquiry-based science practices on a weekly rather than daily basis.

Teachers’ use of Structured and Guided forms of inquiry were noticeably higher than the Open method. This suggests a shift in practice should occur which can allow teachers to provide students with more freedom throughout the science learning experience, thus engaging in more and better forms of true Open inquiry. If Inquiry-based teaching is to really become the foundation for science teaching and “prepare Ohioans to apply increased knowledge and skills to meet the demand of the 21st century” (Ohio Core, 2007, p.1), then increased State and local level policies need to be adopted; especially when considering the new science graduation requirements effective July 1st, 2010 (Ohio Core, 2007, p.1).
Findings also suggest that several key factors are present which could vehemently affect teachers’ potential for using inquiry on a frequent basis. Teachers indicated that aspects of teaching such as time, class size and available materials were important factors which influenced their usage of inquiry. Although teachers initially indicated community resources were not an influencing factor in the use of inquiry, a careful analysis suggested that teachers were not even sure or aware which community resources were at their disposal and available to the school community. Better and more effective relationships, then, should exist between communities, schools and their administrators in order to make the best possible use when considering these resources into the school science curriculum.

Final Considerations & Recommendations

Based on this study’s findings and discussion, the researcher has summarized several recommendations which can improve teachers’ inquiry beliefs and practices in Southeastern Ohio:

- Instances should be identified where both pre-service and in-service teachers can be more exposed to inquiry experiences. Such a practice could potentially ease current and future educators’ comfort level with inquiry.
- Schools should invest effort initiatives towards the development of action plans to remediate time as such a large factor towards the use of inquiry.
- School administrations should supply opportunities for teachers to voice concerns regarding facilities available for science teaching. This could positively affect when and how teachers rely on their science teaching facilities.
• Teachers and school administrators should carefully assess community support and resources available that could enhance science inquiry experiences at a local school level.

Additional research is warranted in order to better understand why experienced science teachers in Southeastern Ohio public schools do not display a clear understanding of inquiry and its relationship to science teaching. Further research is also suggested in order to establish interactions between the amounts of time teachers have at their disposal and inquiry-based practices. Time was an unpredicted finding towards the factors that negatively affect teachers’ use of inquiry. Time was also a surprising factor uncovered in our study and deserves further consideration in future research projects.

Future studies should also consider how the community is portrayed in schools and how its resources are invested towards the science curriculum and inquiry-based learning opportunities in Southeastern Ohio local schools. Researchers also might broaden the scope of this study to include all of Appalachian Ohio in further studies. Such a study would be able to compare a wider spectrum of schooling and Inquiry-based teaching and learning in the state. This would also allow for better informed comparisons between Southeastern Ohio vs. other regions of the State.

Whether our students become future scientists, doctors or homemakers, Science and Inquiry-based opportunities have the power to change students’ perceptions of life and matter and also prepare them for the future. It is important then to further study, assess and improve these experiences in order to guarantee our society a quality of scientific knowledge. Effective Science-Inquiry programs have the potential to prepare
both teacher and student in a way of learning that promotes scientific literacy and critical thinking habits of mind. (NSTA, 2007). Findings portray how teachers in Southeastern Ohio perceive, relate and rely on Inquiry-based practices but also supports the need for improvement in these experiences should Inquiry truly become the “central strategy for teaching science” (NRC, 1996) in Ohio schools.
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<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Please indicate the amount of years you have been in service for the following:</td>
<td></td>
</tr>
<tr>
<td>Teaching science</td>
<td></td>
</tr>
<tr>
<td>Teaching science at this school</td>
<td></td>
</tr>
<tr>
<td>2. What was your undergraduate degree major?</td>
<td></td>
</tr>
<tr>
<td>* 3. Do you currently hold a Master’s degree?</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes (please indicate in what field)</td>
<td></td>
</tr>
<tr>
<td>4. Do you currently hold a doctoral degree?</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes (please indicate in what field)</td>
<td></td>
</tr>
</tbody>
</table>
Science Instruction & Facilities Survey

5. What kind of License/Certification do you currently hold?
   - Professional
   - Provisional
   - Substitute Teaching
   - Don’t have one
   - Other (please specify)

6. What are you currently Licensed for in the State of Ohio? (please select all that apply)
   - Physical Science
   - Chemistry
   - Physics
   - Biological Science
   - Life Science
   - Earth & Space Science
   - Environmental Science
   - Other (please specify)

7. Please indicate your gender.
   - Male
   - Female

8. What grade level(s) do you currently teach?
   - 7th
   - 8th
   - 9th
   - 10th
   - 11th
   - 12th
Science Instruction & Facilities Survey

9. What is the approximate percentage of students eligible for free or reduced lunch program at your school.


10. Please identify your school’s estimated ethnic composition percentage.

% Caucasian (white)
% African American
% Hispanic
% Asian
% Other

11. Please indicate your school’s estimated passing rate % on the OGT Science:


12. Please Indicate your school’s state designation.


13. Which of the following professional development opportunities have you participated in over the last 5 years?

- None
- Scheduling
- Differentiated Instruction
- Assessment
- Inquiry
- Backward design
- Other (please specify)

14. Please describe which Professional Development activities have had the greatest impact on the way you teach Science?
Science Instruction & Facilities Survey

15. How would you describe the facilities Available for teaching Science at your school? (please check all that apply)
   - Classroom (with desks)
   - Classroom (with tables)
   - Classroom with Lab facility (sinks, burners, gas, etc...)
   - Trailer Classroom
   - Other (please specify)

16. How would you describe the facility where YOU teach Science? (Please check all that apply)
   - Classroom (with desks)
   - Classroom (with tables)
   - Classroom with Lab facility (sinks, burners, gas etc...)
   - Trailer Classroom
   - Laboratory (fully equipped)
   - Other (please specify)

17. What kinds of teaching resources, equipment or materials do you use for teaching Science?
### Science Instruction & Facilities Survey

**18. How adequate is your facility in supporting Science teaching?**

- [ ] Not at all
- [ ] Minor extent
- [ ] Moderate extent
- [ ] Major extent

**Why? (please describe)**

[Text box for response]

**19. Please describe the approach you typically use for teaching Science?**

[Text box for response]
Science Instruction & Facilities Survey

* 20. To what extent do you believe Inquiry-Based Instruction advances student learning?
   - [ ] Not at all
   - [ ] Minor extent
   - [ ] Moderate extent
   - [ ] Major extent

   Why?
   [ ]
   [ ]
Science Instruction & Facilities Survey

21. In your own words, how would you define Inquiry-Based Science teaching?


22. How often do you believe Inquiry should be used in the Science classroom?

- Never
- Monthly
- Weekly
- 1-3 times/week
- Daily

23. What single biggest obstacle prevents you from implementing Inquiry-Based Science teaching?


Science Instruction & Facilities Survey

24. What type(s) of Inquiry method(s) do you use in your Science classroom? (check all that apply)

☐ Structured Inquiry
☐ Guided Inquiry
☐ Open Inquiry
☐ Coupled Inquiry
☐ Don’t know what these are

Please describe how you use these in your practice.

25. How often do you use the following Inquiry Methods?

<table>
<thead>
<tr>
<th>Inquiry Method</th>
<th>Never</th>
<th>Monthly</th>
<th>Weekly</th>
<th>2-3 times/week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structured Inquiry</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Guided Inquiry</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Open Inquiry</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Coupled Inquiry</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Science Instruction & Facilities Survey

26. How often do you rely on Inquiry-Based teaching in your practice?

- Never
- Monthly
- Weekly
- 2-3 times/week
- Daily
## Science Instruction & Facilities Survey

**27. To what extent do your students take part in the following:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Monthly</th>
<th>Weekly</th>
<th>2-3 times/week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take part in student-led discussions</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Participate in discussions to deepen science understanding</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Participate in Science presentations before the class</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Read Science text books in class</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Work to solve real-world problems through science</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Share/discuss ideas or solve problems with each other in work groups</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Participate in hands-on science activities and/or lab experiences</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Take part in an inquiry activity or investigation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
### Science Instruction & Facilities Survey

28. How often do your students take part in the following?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Monthly</th>
<th>Weekly</th>
<th>2-3 times/week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record, represent and/or analyze scientific data</td>
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<tr>
<td>Prepare written science reports based on observations</td>
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<tr>
<td>Write Journal reflections on activities</td>
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<tr>
<td>Draw their own scientific conclusions based on observations and experiments in class.</td>
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<tr>
<td>Describe what they know about a topic prior to being taught</td>
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<tr>
<td>Use or bring community resources to the classroom</td>
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<tr>
<td>Use calculators, computers or probes to help solve science problems</td>
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<tr>
<td>Evaluate their own science work in class</td>
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<tr>
<td>Design and conduct their own investigations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participate in experiments involving scientific discovery activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ask and verify their own questions</td>
<td></td>
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</tr>
</tbody>
</table>
**Science Instruction & Facilities Survey**

29. To what extent do the following factors negatively impact your ability to deliver Inquiry-Based instruction?

<table>
<thead>
<tr>
<th>Factor</th>
<th>Not at all</th>
<th>Minor extent</th>
<th>Moderate extent</th>
<th>Major extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing equipment</td>
<td></td>
<td></td>
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<tr>
<td>Available materials &amp; resources</td>
<td></td>
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<tr>
<td>Physical conditions of room (ceilings, walls, ventilation etc...)</td>
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<td></td>
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<tr>
<td>Room size and configuration/layout</td>
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<td></td>
</tr>
<tr>
<td>Professional Development (Training, Seminars, materials etc...)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mastery of subject matter</td>
<td></td>
<td></td>
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<tr>
<td>School administration support &amp; commitment</td>
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<td></td>
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<tr>
<td>Community involvement</td>
<td></td>
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<tr>
<td>Other (please specify)</td>
<td></td>
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</tbody>
</table>
### Science Instruction & Facilities Survey

30. What kinds of community resources are available to support Inquiry-Based Science teaching at your school?

<table>
<thead>
<tr>
<th>A</th>
<th></th>
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</thead>
</table>
APPENDIX B: IRB APPROVAL

A determination has been made that the following research study is exempt from IRB review because it involves:

Category 2. research involving the use of educational tests, survey procedures, interview procedures or observation of public behavior.

Project Title: A Study Examining the Quality of Inquiry-Based Science Instruction in Southeastern Ohio

Primary Investigator: Daniel Pacheco

Co-Investigator(s):

Advisor: Danielle Dani

Department: Teacher Education

Robin Stack, CIP
Office of Research Compliance

08/14/2009

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved (as an amendment) prior to implementation.
The amendment, detailed below, and submitted for the following research study has been approved by the Institutional Review Board at Ohio University.

**Project:** A Study Examining Inquiry-Based Science Instruction in Southeast Ohio

**Amendment:** Survey Revision; Title Change; Add Chance to Win Gift Card

**Primary Investigator:** Daniel Pacheco

**Co-investigator(s):**

**Advisor:** Danielle Dani

**Department:** Teacher Education

---

**Rebecca G. Cale**, AAB, CIP  
Office of Research Compliance

9/25/09  
Date
**APPENDIX C: RESEARCH ANALYSIS METHOD/APPROACH**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Instrument</th>
<th>Analysis Method/Approach</th>
</tr>
</thead>
</table>
| 1) What are teachers’ beliefs and perceptions of Inquiry-based Science? | Survey questions: 13 | Frequency Measures  
Content Analysis (Freq measures, 19)  
18, 19, 20  
20a | Descriptive statistics  
Correlations with Q 2-4, t-Test with Q.1  
19b, 21-22  
18 | Content Analysis  
Crosstab X² with Q.12 |
| 2) To what extent do teachers in rural schools rely on Inquiry-based strategies for teaching science? | Survey Questions: 12, 21 | Descriptive  
Frequency Measures  
23  
ANOVA (Q. 23, 24+25)  
24-25  
-Descriptive  
-Correlation Analysis w/Q. 1(# years actual science teaching)  
26 | ANOVA with Q22(compare with actual use of inquiry)  
Correlations with Q. 1,4,7  
T-test with Q. 7(gender) |
13,(14-15”other”),  
16, 19b,22, 26b,  
27-28 | Content Analysis  
Freq Measures and ANOVA with Q. 22  
(Is there any relationship?)  
26  
X²  
Pearson Correlation w/Q.1b(years teaching @ school) and T-test with Q.7/gender  
27  
26  
One way ANOVA with Q. 12 (Is there any relationship between these at all?) |
Good Day,

Hello. My name is Daniel Pacheco and I am a graduate student in Ohio University at the College of Education. I am currently working on gathering data for my Thesis project. I contact you today to inform you about this study, which will investigate middle and secondary Science teachers' beliefs, perceptions and use of Inquiry, laboratory practices, as well as the factors that impact the use of Science Inquiry in the classroom. The study will target secondary Science teachers in Southeastern Ohio.

For this reason, I have selected your school's Science teachers as possible participants for this study. Teachers will simply access an emailed web link and respond to a survey, which should take approximately 10-15 minutes to complete. This survey will be emailed to teachers by the end of this week with a two week response window. Survey responses and teachers' information will remain confidential throughout the whole process. As a reward for their help, teachers will opt to win one of 50 Starbuck's Coffee Gift Cards upon survey response and completion.

I am writing to you today to request your assistance by encouraging your teachers to participate in this vital study to Science in Southeastern Ohio. This study is timely and critical as there is limited, if any, published information for this region. If you would have any concerns or questions, please feel free to contact me by email or telephone.

Thanks for your Support,

Daniel Pacheco

Ohio University
COE-Teacher Education
dp108907@ohio.edu
Ph. 567-712-1540
APPENDIX E: LETTER TO PARTICIPANTS

Hello,
You have been selected to participate in a Thesis Research project on Science Inquiry. This project focuses on middle and secondary Science teachers' beliefs, perceptions and use of Inquiry, laboratory practices, as well as the factors that impact the use of Science Inquiry in the classroom.

For these reasons, I invite you to take part in this project by completing an online survey. This is a straightforward survey which should only take 10-15 minutes to complete. You will have until October 30, 2009 to access and respond to the survey. For your time and participation, upon completing the survey, you will have the chance to receive one of 50 Starbucks Gift Cards. You can access the survey at the following link:

Your responses and/or opinions will remain confidential throughout the whole process and will not be shared or distributed, in any way, with third parties other than utilized for the sole purpose of this research project.

I value your time and appreciate your support in completing this survey.
Thank You,

Daniel Pacheco
Ohio University
COE-Teacher Education
Email: dp108907@ohio.edu

Terms of the study:
By choosing to complete this survey, you are agreeing that:
- you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions
- known risks to you have been explained to your satisfaction.
- you are 18 years of age or older
- your participation in this research is given voluntarily
- you may change your mind and stop participation at any time without penalty or loss of any benefits to which you may otherwise be entitled.
- by completing the survey you agree to these terms and conditions
- you will have the chance of winning one of 50 Starbucks Coffee $5 Gift Cards.

If you have any questions regarding this study, please contact Daniel Pacheco at dp108907@ohio.edu or Dr. Danielle Dani at dani@ohio.edu.

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University.