2015

Restructuring High School Science Curriculum: A Program Evaluation

Cathy Robertson
Walden University

Walden University

COLLEGE OF EDUCATION

This is to certify that the doctoral study by

Cathy Robertson

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Rachel Pienta, Committee Chairperson, Education Faculty
Dr. Kimberley Alkins, Committee Member, Education Faculty
Dr. Miranda Jennings, University Reviewer, Education Faculty

Chief Academic Officer

Eric Riedel, Ph.D.

Walden University
2015

Abstract

Restructuring High School Science Curriculum: A Program Evaluation

by

Cathy Jean Robertson

EdS, Walden University, 2011

MS, Southeast Missouri State University, 2006

BS, Southeast Missouri State University, 1999

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

February 2015

Abstract

One rural Midwestern high school discovered a discrepancy among school, state, and national science skill attainment, verified by ACT scores. If students do not acquire vital science skills, they may not perform proficiently on science tests, thus impacting future college options. Inquiry based instruction and constructivism provided the basis for the theoretical framework. This study questioned associations between ACT scores, inquiry science technique usage, and ACT standard usage (Phase 1), and teachers' views on science instruction (Phase 2). This sequential explanatory mixed methods program evaluation included 469 ACT scores, surveys sent to 9 science teachers, and 8 interviews. Phase 1 used the inquiry science implementation scale survey and an ACT college readiness standards workbook to determine proportional associations between datasets. Descriptive statistics, one-sample *t* tests, and binomial tests were used to analyze Phase 1 data. Phase 2 interviews augmented Phase 1 data and were disassembled, reassembled, and interpreted for parallel viewpoints. Phase 1 data indicated that teachers use a slightly above average amount of inquiry and science ACT standards in the classroom; however, most science students did not test above the curriculum and there were inconsistencies in standards covered. Phase 2 data revealed teachers need time to collaborate and become skilled in inquiry methods to rectify the inconsistencies. The project was an evaluation report. This study will foster positive social change by giving the district a plan: adapt the science curriculum by integrating more ACT and inquiry standards and participate in more professional development that applies inquiry as a tool to increase science skill proficiency, thus generating locally competitive students for college and the workforce.

Restructuring High School Science Curriculum: A Program Evaluation

by

Cathy Jean Robertson

EdS, Walden University, 2011

MS, Southeast Missouri State University, 2006

BS, Southeast Missouri State University, 1999

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

February 2015

Dedication

I would like to dedicate this paper to my family and friends. To my husband Tommy, over the years, you have watched me fall and each time you have been there to help me get back up. To my son Aidan, God brought you into my life at the perfect time, and through you I have learned the purest forms of love and happiness. To my parents, you have shown me that hard work is all in a day's work. To my siblings, you have taught me that there is always a little bit more fight left in me. For the rest of my family and friends, each one of you has been there to listen to the cries of protest and the subsequent elevated eagerness to complete this paper. To conclude, I must dedicate this paper to God. You have carried me through the darkest moments of my life, and because of you I now have the strength to walk.

Acknowledgments

I would like to recognize my committee chair, Dr. Rachel Pienta, for teaching me that all of the corrections really were for a reason. I have to express a special thank you to my second chair, Dr. Kimberley Alkins, for stepping in to help me finish this journey. I would also like to acknowledge my all of my past teachers from Walden University for helping me determine my focus. Last but not least, I must say thank you to my *Yoda of English,* Alicia. Without your help, I never would have made it through the *semicolon era.*

Table of Contents

List of Tables

List of Figures

Section 1: The Problem

Introduction

According to American College Test (ACT) 5-year trend data, QRS High School's (pseudonym) science skill scores are lower than state and national scores. This study employed a mixed methods program evaluation to create a platform for change in QRS High School; the ultimate goal of action research is to emancipate individuals from any limitations hindering their growth (Creswell, 2008). Specifically, ACT background data (see Appendix B) indicates science ACT scores at QRS high school are slightly below state and national averages, within 1%, but the percentage of students considered ready for college is 7% below state and national scores (ACT, 2011a). As a statistical comparison, the 5-year average between QRS High School and state scores for other ACT tested areas are within 1% for math and reading and 1.3% for English (ACT, 2011a). The 5-year averages for students meeting college readiness benchmark statistics for other tested areas include 68.6% for English, 38.6% for math, and 50.6% for reading. Although the data are comparable for all four areas, in reference to the difference between the high school's scores and state's scores, the 5-year average of students ready for college in science was 17.2% less than math, 29.2% less than reading, and 47.2% less than English within QRS High School. This analysis demonstrates an inconsistency, or gap in practice, within the high school, demanding immediate attention by the science department.

According to the standards proposed by the 2002 No Child Left Behind Act (NCLB), schools should increase testing performance so a gap, such as the one presented, no longer exists (Tavakolian & Howell, 2012; Wagner, 2008). For example, Polikoff (2012) evaluated student learning, including science, in relation to instructional alignment since the implementation of NCLB. The results indicated an increase in performance when teachers performed an instructional alignment to state and federal standards. As such, this project study focused on narrowing the gap through an increase in science skill achievement. The closure of this gap began by reviewing archival science ACT scores, obtaining classroom-level data about inquiry usage within the department, and then evaluating the current science curriculum in QRS High School. The curriculum evaluation was designed to analyze instructional alignment with assessed ACT skills. However, at the time of this study, the science department at QRS High School did not employ a program designed to address ACT college readiness skills. Furthermore, data evaluating the effectiveness of the current curriculum was lacking and, therefore, undetected deficiencies in the curriculum could have contributed to the problem. The program evaluation, specifically a needs assessment, became the basis for recommended changes to future practices in the science department regarding scientific skills and concepts addressed during assessments which measure all, or some, of the following: "the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences" (ACT, 2013b, para. 1). This study focused on science because the researcher of this project is a high school science teacher. Furthermore, as science is not a state tested area at QRS high school, the science department receives fewer resources and professional development opportunities (C. Ruszala, personal communication, March 15, 2012). Nevertheless, schools must develop an ambitious strategy to improve science scores (Simpson, 2009), and districts need to create educational goals for their students (Bolden, 2012). Reaching targeted goals can help students understand course material. Additionally, students need to comprehend high school science coursework to prepare for postsecondary science. According to ACT, Inc. (2012), school districts and states need to implement educational standards that prepare all students for life after high school. This study data provided the decision criteria for educational standard determination at the QRS High School science department.

Research showed an existing gap in ACT scores and, even more significant, a gap in practice at QRS High School. As a result, I reviewed the science department's current practices. This review directed the subsequent research into the acquisition of science skills to improve practice. I collected data and conducted an internal evaluation of the science department to evaluate practices helping students attain basic scientific skills. This program evaluation could foster a transformation of the science curriculum through the future implementation of additional inquiry based activities in each of the 11 classes taught at the high school. Through this implementation, students could increase their knowledge and skills base to prepare them for college and their future careers. This transformation would take shape at the start of high school and follow a student throughout his or her high school career. Teachers could help students with science achievement by applying constructivist concepts developed by Dewey (1916), Piaget (1928/2009), and Vygotsky (1978). A rise in student achievement could result in (a) a rise in local assessment scores and possibly state scores, (b) an increase in students going on to a postsecondary education, and (c) more students graduating from college and possibly returning to their hometown as productive community members.

In Section 1, I present a problem in one rural Midwestern town. The topics that I discuss in Section 1 include the local problem; rationale for conducting a project study, including local evidence and evidence from professional literature, the significance of the study, research questions, theoretical framework, implications of the study, and a summary.

Definition of the Problem

Data analysis of ACT data revealed the science curriculum in QRS High School needs modifications. As such, a goal of this study was to accelerate curriculum changes in the science department while simultaneously preparing students for life after high school. When attempting to increase test scores, school curriculum is vital (Allen, 2007; Burton & Frazier, 2013; Sheninger & Devereaux, 2012). As stated by the QRS High School science department chair, the science curriculum in place was outdated and rarely followed (personal communication, September 3, 2012). More specifically, the curriculum was last updated in 2006 and located in a computer program no longer utilized by the district (teachers lost access when the district did not renew the contract). The science department did not have printed copies of curriculum documents because the district wanted to make a technology move. As such, the science teachers were unable to quickly verify if their chosen lesson plans covered school, state, or federal standards.

A secondary concern exists in the town dynamics. For many of the adults in this rural community, a blue-collar job with hourly wages provides the income for their families. The community has a population of 4,391 people and is comprised of roughly 10 factories, two grocery stores, five gas stations, and 10 restaurants. The high school served an average of 887 students per year between 2006 and 2010 (Department of Elementary and Secondary Education [DESE], 2010a), and according to the Office of Social and Economic Data Analysis (2011), the percentage of children living in poverty in the county (subsequently referred to as Alias County) rose 6.4% between 2000 and 2008. This is a town where the burden of poverty is the norm rather than the exception. However, development and growth could help alleviate some of this burden and consequently benefit the town (Alvarez, & Barney, 2013; Perry, Arias, López, Maloney, & Servén, 2006).

Helping students obtain science skills necessary for college or the workforce would foster an educational transformation in QRS High School. Some students choose to withdraw from the school before graduating. Other students may finish high school or obtain a General Education Diploma (GED), yet do not attend college. Almost half of the student population obtains a 2-year or technical school degree. Between 2006 and 2010, the average percentage of graduating seniors attending a 4-year college or university was 18.1% as compared to the 18.5% entering directly into the work force (DESE, 2010d). A study by Datnow, Solorzano, Watford, and Park (2010) discussed the concern of many low-income young adults making the transition from high school to the work force or not making a transition at all. As such, educators need to help ensure students graduate and prepare them for the postsecondary education system and work force.

Although the poverty of the town has been a burden on the local high school, the high school must still prepare students for 21st century jobs. According to ACT (2013a), scores continue to indicate the United States must improve student education so they can be internationally competitive for 21st century jobs. Furthermore, only 47.5% of the graduating seniors from QRS High School took the ACT in 2010 (DESE, 2010b). Additionally, only 17% of those students taking the ACT in 2011 were ready for college science; the 2007 to 2011 5-year average was 21.4% (ACT, 2011a). Consequently, improvement of the science curriculum at QRS High School could facilitate a rise in the local high school assessment standings.

Rationale

Evidence of the Problem at the Local Level

Five-year science ACT statistics displayed a trend demonstrating students are unprepared for college. ACT Profile Reports from 2007 to 2011 showed the average percentage of students meeting college readiness benchmarks in science to be 20.8% at the local level, 31.6% in the state, and 28.6% at the national level (ACT, 2011a; ACT, 2011b), displayed in Appendix B. Data from the reports show the local level is 7.8% lower than the national level and 10.8% lower than the state level. These percentages illustrate the need to increase science achievement at the local level.

More than half of the graduating seniors at QRS High School are not taking the ACT, despite an assigned academic advisor throughout all four years of high school. Additionally, only three students from the high school took the SAT in the past 5 years (guidance office at QRS High School, personal communication, March 28, 2012). This number translates to roughly 0.3% of the student population. Conversely, the average number of graduating seniors from this high school entering a 2-year college or university was 43.1% (DESE, 2010d). While very few students at QRS High School take the SAT, many take placement tests at the local community college and tend to test into remedial or standard courses. Nevertheless, 2-year colleges and universities require students to take the ACT. Colleges are assessing the skill level attained by students throughout high school. The statistics presented provided the needed evidence to reevaluate a faltering science curriculum and to place an emphasis on students acquiring the necessary skills to be successful in college. If the school fails to increase science achievement and the number of students taking tests such as the ACT, students are at a higher risk for not getting in to college, not getting in to advanced science courses, or having to take remedial science courses to reach average proficiency.

Five-year data trends demonstrated a need to increase science ACT scores. However, the data also illustrated the need to increase the number of students interested in, and taking, more science, technology, engineering, and math (STEM) courses.

STEM Careers

There are a multitude of STEM careers for people entering the workforce. Unfortunately, there are not enough students graduating with a STEM degree; therefore, there are not enough workers to fill vacant positions (Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011; Schiavelli, 2011). The United States ranks 20th in the world for STEM degrees (Hall et al., 2011; Zhe, Doverspike, Zhao, Lam, & Menzemer, 2010), partly because American workers have not acquired the appropriate skills needed for STEM work (Kelly, 2012). The STEM industry is dependent on having workers who are considered highly qualified, yet according to ACT (2013a), only 36% of graduating seniors in the United States were prepared for college science, necessitating an increase in the number of students considered ready for college science. Table 1 demonstrates only 12.3% from the class of 2012 planned to major in STEM-oriented careers. Furthermore, only 5% of this number represented science careers. As such, the high school must increase efforts to get students interested in STEM courses.

Table 1

Class of 2012 STEM majors

STEM Major	Students	
	Number enrolled	Percent of class
Pre-engineering	6	3.35
Biotechnology	2	1.12
Biology	2	1.12
Biomedical engineering	1	0.56
Computer information Technology	2	1.12
Computer Science	1	0.56
Engineering management	2	1.12
Exercise science	1	0.56
Mathematics	1	0.56
Microbiology	1	0.56
Mining engineering	1	0.56
Physics	1	0.56
Pre-medicine	1	0.56
Total	22	12.29

Note. There were 179 graduating seniors in the Class of 2012. From QRS High School Guidance Office, personal communication, September 12, 2012

Evidence of the Problem from the Professional Literature

According to ACT and DESE reports for ACT scores from 2007 to 2011, QRS High School students scored below state and national science averages (ACT, 2011a, 2011b; DESE, 2010a). Students must have a solid knowledge base before taking assessments and master necessary skills to be successful in STEM work (Asunda, 2011). Mastering these skills gives students an advantage when pursuing STEM careers.

QRS High School students lack scientific reasoning skills and have a difficult transition to postsecondary science (A. Schoonover, personal communication, January 24, 2012). This assertion is deduced primarily from ACT data, as the school does not collect its own data on STEM skills and the transition to college. However, National Assessment of Educational Progress (NAEP) data from 2011 ranked Missouri eighth graders 21st in science scores, meaning 42% of states scored higher (National Center for Education Statistics, 2012). Bolden (2012) stated a lack of science instruction at lower grade levels compounds the issue, creating a system in which students perform poorly in high school science courses and on science assessments. The transition to high school and college is difficult when students are unable to apply necessary science practices to assessments. The four necessary science practices include “identifying science principles, using science principles, using scientific inquiry, and using technological design” (National Center for Education Statistics, 2012, p. 2). When a student is lacking that knowledge, in part from an inadequate curriculum, he or she might score lower on assessments and may have difficulties with college science courses.

Research relating high school and college grades indicates that many students are unprepared for the rigors of their postsecondary science courses (Bowers, 2007; Jensen & Moore, 2008), signifying students have not acquired the skills necessary for a successful transition to college science. For instance, Walsh (2010) cited possible grade inflation in high schools within their competitive environments, meaning school districts near each other are adjusting their bottom line to appear appealing to the public. The study did show, however, teachers might readjust scoring to reflect the student's true grade. Jensen and Moore (2008) discussed high school grade inflation and the absence of academic challenge in their report, which argued only 33% of students felt challenged during high school. Furthermore, the students in the study by Jensen and Moore (2008) were a representative sample of those students found in a typical college science classroom; the average student ACT score was 20.

National NAEP Versus the International PISA

Using national NAEP data and Programme for International Student Assessment (PISA) data provides a way to determine how US students rank versus similar students in other Organisation for Economic Co-operation and Development [OECD] countries. Programme for International Student Assessment measures how effective students are at applying subjects to real-world contexts by age 15 (National Center for Educational Statistics, 2008,) and showed the United States' ranking is average on the scientific literacy scale, with 12 out of the 33 countries scoring higher. Only 29% of U.S. students scored "at or above level 4 on the science literacy scale," which demonstrates the ability to "complete higher order tasks" (Fleischman, Hopstock, Pelczar, & Shelley, 2010, p. iv).

In other words, 29% of U.S. students have the ability to apply knowledge to more complex science problems. Both NAEP and PISA measure scientific knowledge; however, NAEP includes a practical component. Of the topics tested, 83% are comparable but no data comparison results were available at this time (National Center for Educational Statistics, 2008). Data results from international PISA testing have consistently placed the United States in the middle of the rankings (Bybee, 2007, 2009; Bybee & McCrae, 2011), but 12th grade science scores declined from 1996 to 2005 on NAEP (Liu, Lee, & Linn, 2010). National and international scientific testing data indicates a need for an increase in scientific literacy to increase scores (Bybee, 2007, 2009; Bybee & McCrae, 2011). The United States' PISA ranking suggests a need for systemic change (Shymansky, Yore, Annetta, & Everett, 2008). International testing data are well-defined and demonstrate the United States is trailing behind other countries in terms of offering a science curriculum that teaches students scientific competencies and skills (Bybee & McCrae, 2011). The data provide additional support for the evaluation of the science curriculum in QRS High School.

Definitions

Achievement gap: The difference in the scores between two different groups of students on different measures, such as achievement levels (Murphy, 2009).

Adequate yearly progress: A government-mandated process for which a school district must show a steady increase each year in state testing and graduation rates until 100% is achieved by the year 2014. A state can set a different deadline to reach 100% for its graduation rate (National High School Center, 2006).

Benchmark score: The ACT is a predictor of college grades. A benchmark score is “the minimum score needed on an ACT subject-area test to indicate a 50% chance of obtaining a B or higher or about a 75% chance of obtaining a C or higher” (ACT, 2011b, p. 3).

College and career readiness standards: Provides a description of the likely skills students know, given a specific score range on the ACT (ACT, 2014), and the skills needed to be considered college ready (ACT, 2011e). These skills include interpretation of data (IOD); scientific investigation (SIN); and the evaluation of models, inferences, and experimental results (EMI; ACT, 2014).

Common core state standards initiative: Provides the United States education system, K-12, with a consistent and higher standard. This initiative is aimed at supporting the acquisition of needed knowledge and skills to be a successful postsecondary student (ACT, 2011g) and is to align with college and career readiness standards (ACT, 2009a). The common core state standards initiative is the result of a collective effort after the passing of the American Recovery and Reinvestment Act of 2009 (ARRA) (ACT, 2009).

Course selection: Demonstrates whether a student follows a typical core curriculum or a noncore path (ACT, 2011b).

Inquiry based instruction: Designing, and applying, a curriculum that allows students to explore through extended investigations in the classroom (Minner, Levy, & Century, 2009, p. 476).

Inquiry based learning: Active learning through critical and logical thinking; often reflects the work of scientists (Minner et al., 2009).

Rural, qualitative perspective: The characteristics describe the area, such as family and community life, socioeconomic status, lack of access to resources, and education (Vernon-Feagans, Gallagher, & Kainz, 2010).

Rural, quantitative perspective: The statistical properties describe the area, such as population, size, and location (Vernon-Feagans et al., 2010).

Significance

The purpose of this study was to help the students at QRS High School improve their science skills while simultaneously providing suggestions for the teachers on how to best develop these skills in their students. The science teachers can make suggested changes stemming from the results of this program evaluation. Increasing students' science skills base would increase their success in college science programs. Furthermore, there is a positive relationship between the attainment of skills and ACT scores for individual students at QRS High School. Obtaining ACT scores between 21 and 36 would earn an individual student a scholarship. Scholarships range from reimbursement for the cost of a basic ACT up to $500 plus reimbursement for a basic ACT. While persuading students at QRS High School to take the ACT can be a challenge "in a town where generational poverty is a concern, the simple act of having $35 reimbursed as a result of an ACT score could enhance the confidence level of an individual student" (S. Ulrey, personal communication, December 21, 2012). The high school is a major focal point in the town, and a higher confidence level amongst students could influence a positive transformation in its local setting.

Research Questions

As stated earlier, many QRS high school students score poorly on the science component of the ACT. Research showed a relationship between low science skill acquisition and students failing college readiness benchmarks in science. There is an insufficient number of research studies focused on obtaining the necessary science skills needed to transition successfully to college science or the lack of science skills. The absence of such literature demonstrates a need for additional research (Nagowah & Nagowah, 2009).

In this project study, I had questions about student achievement in high school science and, as a result, student preparedness and achievement in college science. Consequently, it was necessary to research what science skills are necessary in high school and college. I also researched what inquiry methods teachers use to teach students these skills for local and state testing, which could be beneficial in national or even international testing. Accordingly, the following are research questions for this study.

Phase 1: Quantitative Questions

1. What is the variation in the proportions of past student ACT scores and ACT science college readiness standards covered in the science curriculum at QRS High School?

This measurement was through one-sample *t* tests, which give “an indication of the separateness of two sets of measurements” (Changing Minds, 2013, para. 1), and binomial tests, which evaluate proportions (IBM, 2012). The tests were run on ACT scores and ACT science college readiness standards from the curriculum review worksheets workbook taught in the science classrooms.

2. What is variation in the proportions of past student ACT scores and scientific inquiry concepts the science teachers at QRS High School are exposing their students to in the classroom?

The ACT measures many scientific inquiry concepts (ACT, 2013b). Therefore, this research question was designed to examine the amount of inquiry occurring at QRS High School and attempt to correlate it to ACT scores. The measure of inquiry was through the number, and frequency, of techniques applied in each teacher's classroom as determined in the inquiry science implementation scale (ISIS). This was quantified through one-sample *t* tests and binomial tests of ACT scores and inquiry techniques taught in the science classrooms, as measured by the ISIS.

Phase 2: Qualitative Question

3. What are science teachers' viewpoints concerning scientific inquiry's impact on student acquisition of science skills at QRS High School?

Review of the Literature

I conducted a literature review to improve my understanding of inquiry based instruction as a tool to help increase the science skills of students at QRS High School. To investigate, I reviewed various sources on achievement gaps, science skills, testing and assessments, program assessments, coursework, and articulation agreements. The organization of the literature review includes (a) a theoretical review with a historical basis for inquiry based instruction and current studies related to search parameters used to provide a web of resources to increase science skills at QRS High School and (b) the function of the current study in terms of adding to research and the involvement of social change.

I conducted an exhaustive search for resources through multiple databases including EbscoHost, ERIC, Google Scholar, the local library, Proquest, and the Walden University online library. Search parameters included Boolean operators and key terms such as the following: achievement gaps in science (Bowers, 2007; Gopalsingh, 2010; Murphy, 2009; National Center for Education Statistics, 2012; Wagner, 2008), inquiry based learning and instruction (Dewey, 1916; Marshall & Horton, 2011; National Research Council, 1996; Piaget, 1928/2009; Shymansky, Kyle, & Alport, 1982, 1983, 2003; Vygotsky, 1978), program assessments (Ali, Yang, Button, & McCoy, 2011; Brandon, Young, Pottenger, & Taum, 2009; Burton & Frazier, 2012; Lee & Ready, 2009), and science skills (ACT, 2013; Asunda, 2011; Baine, n.d.; Feller, 2011; National Center for Education Statistics, 2012; Schiavelli, 2011). Primary search parameters included significant secondary terms including articulation agreements (King & West, 2009; Montague, 2012), coursework (Chabalengula, Mumba, Hunter, & Wilson, 2009; Mo, Yang, Hu, Calaway, & Nickey, 2011; Sawyer 2010), and testing (Joughin, 2009; Lee, 2010; Quinn, 2010; Torgesen & Miller, 2009; Trauth-Nare & Buck, 2011).

Theoretical Framework

Inquiry. Inquiry based instruction has its roots in constructivism, and many researchers credit Dewey (1916), Piaget (1928/2009), and Vygotsky (1978).

Constructivism focuses on the theory that students incorporate previous knowledge so they can actively learn new information through adaptation (Dewey, 1916) while challenged to think critically (Vygotsky, 1978). In the early 1900s, Dewey spoke of students utilizing the instruction a teacher delivers to influence their own self-education, a form of inquiry. More recently, the National Research Council provided this description for components of inquiry in the *National Science Education Standards*:

> 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 (National Research Council, 1996, p. 23).

The relationship between the theory of constructivism and the *National Science Education Standards* (National Research Council, 1996) definition of inquiry is that students utilize their previous knowledge to learn new concepts. Most research, past and current, involving inquiry centers on what students should learn versus the delivery of information. For instance, Minner et al. (2009) noted for each component of inquiry a student should learn, teachers will have various delivery methods. Inquiry provides a platform through which the science teachers at one rural high can increase the skill level of science students as the students are, in a sense, learning to think for themselves.

Science classrooms have utilized inquiry based instruction for decades. While inquiry methods are not the only way to teach a science course, many still consider these methods to be in the forefront of the educational community (Brandon et al., 2009; Marshall & Horton, 2011). Science is an active course in which students and teachers should be working together (Cothern, 2011). In an inquiry classroom, this work equates to solving various questions and problems. For example, both Schmoker (1993, 2006, 2007b, 2011) and Justice, Rice, Roy, Hudspith, and Jenkins (2009) made an argument for transforming a student's critical thinking skills by utilizing the inquiry notion of less content and more thinking where all projects require students to think, analyze, solve, and communicate. An example of this is a laboratory investigation and the associated laboratory report. Combining the ideas of Justice et al. (2009), decrease content coverage over the course of a school year and cover concepts in depth, with those of Schmoker, allow students to take an active role in their education, teachers have the ability to teach an inquiry based program to their students.

Inquiry based classrooms have many benefits. Research by Blanchard, Southerland, Osborne, Sampson, Annetta, and Granger, (2010); Brickman, Gormally, Armstrong, and Hallar (2009); Marshall and Horton (2011); and also seminal work by Shymansky, Kyle, and Alport (1982, 1983, 2003) found inquiry based instruction has the ability to increase students' retention rates and, in turn, improve assessment scores. Additionally, Marshall and Horton (2011) found that when lessons permitted students to function at higher inquiry levels, 17% more class time was utilized. However, the students were more apt to score proficient or advanced on testing. Marshall and Horton

(2011) called attention to the relationship between student cognitive level and teacher presentation, for allowing students time to develop their own inquiry skills deepens their cognitive level and understanding of science. Each of these benefits provides students with valuable materials while, as stated by Dolan and Grady, (2010) and Grady, (2010), accomplishing the task of engaging them in critical thinking. This engagement gives students the ability to apply these skills in their future science careers.

Given the research, inquiry based instruction could be best practice for the science department at QRS High School as a possible solution to the problem of low achievement in science. However, the school needed to determine to what extent teachers employ inquiry based practices in their classrooms; therefore, there was a need to investigate the science curriculum in QRS High School for inquiry components.

Increasing science performance. In this project study, the theoretical base included research from various topics associated with increasing science skills including the following: (a) achievement gaps and possible ways to lessen the gap, (b) ways to help acquire scientific skills, (c) alternative ways to assess students, (d) the quality of coursework, and (e) forming articulation agreements with local colleges to enhance high school curriculums. Each approach is one portion of a larger unit in which QRS High School takes a proactive approach to increase science performance.

Achievement gaps. Achievement gaps in education are inevitable, but the ambition of schools is to minimize the divergence. For instance, Gopalsingh (2010) reviewed achievement gaps in science, math, social studies, and English. The variance between the four core courses is becoming apparent as states are testing in math and

English but not science or social studies. An analysis of 2011 NAEP results reported by the National Center for Education Statistics (2012) showed NCLB has failed to provide the level of improvement politicians hoped for. Results indicate that NCLB has not significantly helped to improve achievement gaps between racial/ethnic groups or gender gaps. In fact, NCLB appears to place undue stress on an already stressed educational system. The need to increase the amount of collaboration through professional development and professional learning communities (PLCs) and the data produced can compound the issue (Koba, Wojnowski, & Yager, 2013). Nevertheless, due to state and federal testing, schools must attempt to manage issues on a local-level. This statement emphasizes the amount of stress placed on districts, teachers, and students to perform well on testing. This study is one effort to minimize the gap.

My research into the challenge to close an achievement gap generated a simple inquiry on how to lessen the distance between groups at QRS High School. In essence, were there measures the school could incorporate to help resolve achievement gaps? Four topics of significance included the following: (a) whether most of the high schools setting the standard for science testing are affluent schools or if there are low-income school districts performing at a higher standard as well; (b) the strategies applied by higher scoring schools in their science classrooms; (c) could QRS High School implement these science strategies without large monetary cost; and (d) the importance of a curriculum in addressing assessments and, therefore, achievement gap issues.

The first topic, which discusses a school's revenue level and success rate on science testing, is actually difficult to answer because school level assessment data, such as ACT records, are not public data. According to C. Ruszala, "Very few school districts are forthcoming with such personal information" (personal communication, April 1, 2012). One study from Minnesota determined the number of free- or reduced-lunch recipients "had a statistically significant association with achievement," (Condon, et al., 2012, p. 11) where schools with a larger percentage of free or reduced lunches tended to score lower on science assessments.

The second and third topics concern program strategies applied in science classrooms in schools with a successful testing record and the implementation of successful strategies at QRS High School without large monetary cost. Multiple researchers (i.e., Asunda, 2011; Baine, n.d.; Feller, 2011; Schiavelli, 2011) discussed increased scores when teachers use strategies for which students have active roles in their education. These strategies include the use of guest speakers, hands-on activities, problem-solving coursework, activities involving collaboration, and technology. Aladejana (2009) discussed an increase in student achievement when science classes use technology, such as the technology used in laboratory experiments. The science teachers of QRS High School could implement many of these strategies without large monetary cost to the district.

The fourth topic addresses the necessity of a curriculum. According to multiple researchers (i.e., Allen, 2007; Burton & Frazier, 2013; Schmoker, 2006; Sheninger & Devereaux, 2012), a principal factor that seems to be quite effective in increasing scores is the curriculum a school has set in place. That curriculum should be rigorous yet practical. For example, Miranda and Hermann (2012) researched curriculum strategies in science and suggested teachers choose a combination that works for their classroom, such as an integrated inquiry approach combining multiple techniques. The QRS School District currently has a science curriculum in place. However, the curriculum is not always applied. Similarly, a secondary strategy initiated by principals and teachers in effective school systems is the use of horizontal and vertical teaming in each subject area (Duffy, 2010). In a National Center for Educational Achievement [NCEA] (2011) report titled *The 20 Non-Negotiable Characteristics of Higher Performing School Systems,* a PreK-12 vertical alignment of the curriculum through a backwards approach (starting with high school) is fundamental. The district details objectives and vertically aligns the curriculum to state standards. Conversely, at QRS School District there is seldom vertical or horizontal teaming to work with the curriculum, which raises questions about how rigorous and practical the set science curriculum is. A solution, with almost no cost to the district, is to use professional development days for true horizontal and vertical teaming. This time would allow the science department to create a definite and viable curriculum. In addition, the entire district could benefit from an increase in vertical and horizontal teaming.

Closing any achievement gap is the goal of NCLB, but the complete closure of this difference may be unattainable. For example, Murphy (2009) and Wagner (2008) called attention to the closure of achievement gaps and discussed that although closing the variance appears to be a simple task, teachers' experiences are quite the opposite. In the past, literature concentrated on the absolute improvement of students, meaning the distance between two groups needs to decline (Murphy, 2009). Teachers and administrators must consider the relative improvement of individual students. Similarly, students who need to improve their learning should get the advantages needed to increase their achievement levels. By doing this, teachers may find it possible to decrease the distance of the gap between groups. For instance, Johnson (2009) and Haak, HilleRisLambers, Pitre, and Freeman (2011) had positive results in reducing achievement gaps in science when students engaged in active learning. In addition, Haak et al. (2011) found a highly structured science classroom could reduce the gap to within 0.4 grade points, verses 0.8 points in a classroom with less structure (p. 1215). This reduction was possible without any monetary cost to the district. While achievement gaps exist, research has shown that simple changes in the classroom can reduce the distance.

Scientific skills. When students lack the skills necessary to succeed in science classroom, teachers must discover new ways of teaching the students so they acquire these skills. According to the National Center for Education Statistics (2012), the four main scientific practices students should master include “identifying science principles, using science principles, using scientific inquiry, and using technological design” (p. 2). The scientific concepts addressed during the ACT include measuring “the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences” (ACT, 2013b, para. 1). The indication here is that mastery of such scientific knowledge could give the students at QRS High School an advantage when applying for college science courses or STEM careers.

Efforts applied in the classroom to improve the science skills of high school students include such items as (a) creating a real-world curriculum, (b) having businesses help determine what students need to learn, (c) participating in more hands-on activities, (d) having guest speakers in STEM careers, (e) performing activities that use collaboration, (f) selecting problem solving coursework, and (g) integrating more technology (Asunda, 2011; Baine, n.d.; Feller, 2011; Schiavelli, 2011). Engaging in these efforts could help QRS High School improve students' skill base.

From a research perspective, the presentation of material can alter a student's perception of science. For example, Scott and Pentecost (2013) discovered inquiry based laboratory components positively affect student views of science classes, and increase achievement. Roberson and Lankford (2010) concluded labs and laboratory notebooks in the science classroom can help students be active and engaged thinkers, critical analyzers, and responsible for their learning. Similarly, Aurentz, Kerns, and Shibley (2011) suggested the use of state-of-the-art equipment to improve student perception, and performance, in science. The use of such research based suggestions could help students connect with real-world curriculums, participate in hands-on activities, use collaboration, complete problem-solving work, and operate some components of technology.

Non research-based courses of action to improve science skills would include having local businesses help determine what skills are important for graduating seniors to know and having guest speakers in the classroom. Both of these suggestions can help students make real-world connections. Each of these types of learning and interactions can transfer to lessons in the classrooms at QRS High School.

Testing and assessments. In the NCLB era, classroom assessments and standardized testing have become the face of education and have altered the dynamics of schools that find themselves pressured by adequate yearly progress requirements (AYP), testing data, current testing trends, and achievement gaps. For instance, Burton and Frazier (2012) and Quinn (2010) called attention to these various points: testing is messy, complicated, and filled with mixed reports and misconceptions about the effectiveness of high-stakes testing. Burton and Frazier (2012) further noted state testing places pressure to conform, making inquiry science teaching more difficult. As a possible solution to the setbacks in testing, Joughin (2009) discussed refocusing assessments and the types of assessments given in the classroom. Joughin (2009) examined utilizing the following four aspects to facilitate and promote learning: make assessments learning tasks, give feedback to the student, help students develop the ability to critique their own work—even for assessments, and have teachers apply the assessment results (p. 2). One college has implemented such strategies in all subjects since 1973, with great success, where the mission of the college is to "make assessment a meaningful and vital way to enhance student learning" (Riordan & Loacker, 2009, p. 176). Each student must master eight different abilities including: "communication, analysis, problem solving, valuing in decision-making, social interaction, developing a global perspective, effective citizenship, aesthetic engagement" (Riordan & Loacker, 2009, p. 177). In essence, the students learn by actually applying their knowledge. Additionally, Liu et al. (2010) tested the hypothesis that an inquiry component, with multifaceted assessments, would be beneficial over traditional teaching. The study tested both middle school and high school students, involving 2,060 participants the first year in a traditional setting and 2,685 participants the second year where only one or two of the units were altered to a 5-day inquiry segment. The results illustrated the hypothesis was correct; however, performance of the students varied by teacher, possibly due to the comfort level of the teacher to implement an inquiry unit. As such, multiple researchers suggest an alternative recommendation to the typical assessment format to measure understanding. Assessment for learning may provide a more suitable environment for students in an inquiry classroom (i.e. Newby & Winterbottom, 2011; Torgesen & Miller, 2009; Trauth-Nare & Buck, 2011). Namely, Newby and Winterbottom (2011) and Trauth-Nare and Buck (2011) endorsed assessment for learning in which students are stakeholders in every aspect of their evaluations, specifically formative assessment. Torgesen and Miller (2009) researched schools that have been successful in assessment for learning and discovered these schools apply the same or similar strategies as those mentioned by Joughin (2009). These strategies include frequent assessments, assessments in multiple forms, assessments with a clear target, teachers giving appropriate feedback, and students participating in self-assessment and peer feedback (pp. 31-37). Moreover, Schmoker (2006, 2007a) made the simple recommendation to place an emphasis on authentic literacy—actually having the ability to think effectively and communicate (2007a). In QRS High School's science courses, these alternate assessments may take the shape of laboratories, a lab practical, or even an assessed oral presentation about a scientist.

If a teacher still focuses on testing, there is a correct way to improve scores. In particular, Quinn (2010) suggested five areas that need to work in conjunction with each other to improve test scores: (a) a school board for which the main focus is on student achievement, (b) a principal focused on instruction, (c) the development of quality assessments including local and state testing, (d) localized improvement plans that focus on the students and student data, and (e) teachers who want to meet all of their state objectives, which are the grade-level expectations (GLE) and course-level expectations (CLE) for high school science in the state. The NCEA (2011) reiterates the information presented by Quinn: all stakeholders must work in a cohesive fashion to increase scores.

Preparing students to take assessments and be successful at them is a difficult responsibility. A teacher who facilitates in the classroom can break down possible barriers students may have. In particular, Deming, O'Donnell, and Malone (2012) presented an educational language barrier issue in science in which students lack the prerequisite language skills to communicate in terms of science, for science is like its own language for which knowledge of that language is crucial for student comprehension and success. As a prompt to increase scientific literacy rates, Foster and Shiel-Rolle (2011) found scientific literacy camps were beneficial for young science students in rural communities. A report from The Center for the Future of Teaching & Learning (2011) stated scientific education, including scientific literacy, of students should begin at an early age so the same students can be successful in their high school science courses. These two studies establish a valuable argument: students must use the concepts in science to build their scientific literacy skills early. Additionally, Torgesen and Miller (2009) found school systems in which the students made greater strides used rich feedback and self-reflection to work on language issues. Thus, the language in assessment mentioned by Kellaghan, Greaney, and Murray (2009) and the authentic literacy discussed by Schmoker throughout his work (1993, 2006, 2007a, 2007b, 2008, 2009, 2011) demonstrate how all content-area teachers, not just science teachers, can use scientific terminology to help their students improve on assessments.

Program assessment. This project study involved a program assessment of the current curriculum in the science department at QRS High School. A program assessment is used to make decisions (Creswell, 2008; Lodico, Spaulding, & Voegtle, 2006, 2010; Spaulding, 2010) and is conducted to improve upon what is already in place. For instance, Spaulding (2008) presented a real evaluation example that is similar to this project study. Two internal evaluators had to evaluate a high school inquiry based science program. The study involved approximately 150 school districts. The evaluators mailed out surveys to participants and conducted visits to 10 schools each year, conducting interviews with science teachers implementing the inquiry based program. The evaluators found the science program to be quite successful in one state, partly due to a 3-week summer training session during which teachers learned inquiry techniques to apply in the classroom. When attempting to expand the program to another state, the evaluators discovered that there was a state ruling in which all new curriculum programs had to undergo a probationary period of one full school year before the teachers could adopt the program. This example functions as a reminder to evaluators that program evaluations do not always go as planned.

Though matters may be unpredictable, program evaluations can be a useful tool in education. Several researchers (i.e., Ali, et al., 2011; Altschuld, & Kumar, 2010; Lee & Ready, 2009) discussed phases that can be present in educational reform during a program evaluation including development of a new program, implementation of the program, and the evaluation. This study focused on the evaluation stage, as there was already a science curriculum in place at the school. More specifically, Yin (2009) and Brandon et al. (2009) applied different instruments to evaluate career education science programs, incorporating the use of pre and post measures, evaluations, and focus groups. Brandon et al. (2009) examined inquiry science programs and their implementation as intended. Furthermore, Brandon et al. (2009) developed the ISIS to determine issues within a program *and* provide understanding of the program. There are currently no other studies that have used the ISIS. Furthermore, ACT (2010a) encouraged educators not to focus on data from an individual year of testing but rather trends in testing over the course of years. As such, this project study focused on past data trends during 5 years, 2007 to 2011, to obtain background data. These studies demonstrate that a program evaluation is an ongoing process, and the evaluators should suggest changes in response to data collections and reflections. A program evaluation should direct the evaluator, not the other way.

Coursework. While it may be an ambitious goal to prepare all students for postsecondary education, it would be remiss not to make an attempt. High schools have a variety of options to help prepare students for college. While QRS High School does not currently have any virtual learning courses, there are various core, advanced placement, and dual credit classes to help prepare students for college. Some of the upper level classes offered include dual credit geology, dual credit calculus, dual credit college algebra, dual credit History I and II, Advanced Placement Psychology, and Advanced Placement English Literature and Composition III and IV. Even with these dual credit and Advanced Placement courses, modifying the science curriculum is one way to benefit students in their academic success.

Research revealed multiple strategies to improve student success in high school so this success will continue into a postsecondary setting. Among the many recommendations are two straightforward suggestions. One recommendation is to assess students' processing skills during actual hands-on work, such as a laboratory investigation so students may acquire the practical science skills to be successful in college (Chabalengula et al., 2009; Scott & Pentecost, 2013). One such tool to assess processing skills is the performance-based lab assessment technique (PBLAT) for which the teacher creates a rubric of a processing skill, such as manipulation of laboratory burner or a microscope, and grades the student while performing the task ranging from "Proficient performance; Limited proficiency: Can use but needs more practice; Cannot do or use: Needs more instruction and practice; Not applicable, not observed" (Chabalengula et al., 2009, p. 35). Another instrument assesses the acquisition of skills during laboratory investigations in which high school students take a scientific skill posttest to determine if they attained the essential skills. Two such examples are the constructive inquiry science reasoning skills test (CISRS; Weld, Stier, & McNew-Birren, 2011) and the test of scientific literacy skills (TOSLS; Gormally, Brickman, & Lutz, 2012). These tests are designed to measure the progress of scientific skills in undergraduate biology students. Both tests show promise in demonstrating when students have acquired inquiry skills, such as analyzing and interpreting, which are both used in laboratory investigations (Gormally et al., 2012; Weld et al., 2011). The ability to process given information is essential in college courses, especially in science courses. A second recommendation is simple and less controversial than other solutions. Mo et al. (2011) suggested encouraging students to take courses that both challenge and prepare them for college, such as Advanced Placement courses. Both suggestions are helpful when conducting a program evaluation.

While preparation for college is important, educators should find it important to evaluate all aspects of an inquiry classroom and not just the level of coursework. For instance, the American Association for the Advancement of Science (AAAS) (2013a) evaluated Biology textbooks and meeting the needs of students. The AAAS started Project 2061 in 1985. The project is an initiative to help Americans become literate in STEM courses (AAAS, 2013b). A portion of Project 2061 included seven categories for evaluation of the quality of support provided to students in biology textbooks, including the following: (a) providing a sense of purpose; (b) taking account of student ideas; (c) engaging students with relevant phenomena; (d) developing and using scientific ideas; (e) promoting student thinking about phenomena, experiences, and knowledge; (f) assessing progress; and (g) enhancing the science learning environment (AAAS, 2013a, para. 1-7). As suggested in the research by AAAS, textbook adoption is an important part of the support system to help improve science students' work in the classroom.

Instructors do not create all coursework equal. This means that a student is not ready for college simply because that student takes three science credits, which is the minimum state requirement. To prepare themselves for college, students should take courses beyond the minimum requirements. For instance, Mo et al. (2011) and Sawyer

(2010) suggested students take additional courses and improve their performance in these courses to prepare for the transition to college. If coursework is not equal, meaning a basic biology class does not equate to an upper-level anatomy class, science students should take extra courses in subjects that will prepare them for possible future STEM careers.

College preparation should start at the beginning of a student's high school career. During their first year of high school, students, parents, and teachers need to produce a viable plan of the appropriate courses to take to prepare the student for college and make adjustments as that student's interest changes (Guidance Office at QRS High School, personal communication, November 07, 2012). From first-hand experience, QRS High School students have multiple resources at their discretion to help prepare for college: (a) an advisory teacher who stays with a student all four years, with each teacher having between 13 and 18 students, (b) a guidance counselor, (c) individual teachers, and (d) a program added in 2011 involving a college and career advisor for some low-income school districts in the state. There are resources at this high school. However, students need to take advantage of these resources in an effort to prepare for life after high school.

When students are not prepared, they must take remedial courses once in college to bring themselves up to the academic standards of the institution and to the level of students who are prepared. Students must seize any educational opportunities available to them (Datnow et al., 2010). This statement reiterates the need for students to prepare themselves *now* for the transition to college and their future career. College preparatory classes are available at QRS High School, but students must take the initiative to help themselves prepare for college. Likewise, teachers must take the initiative to increase expectations in the classroom.

Articulation agreements. Many students at QRS High School will transition from high school to a 2-year community or technical college or a 4-year university. To help with this shift, Burton and Frazier (2012) recommended vertical articulation K-12, King and West (2009) suggested articulation agreements between high schools and community colleges, and Montague (2012) advocated articulation agreements between 2-year colleges and 4-year universities. Articulation agreements are, in a sense, the comparison of curriculums. Moreover, articulation agreements are one response in the solution to create a workforce in the United States that can be internationally competitive (ACT, 2011f). King and West examined articulation agreements and found that they can reduce the amount of time it takes employers to train new workers. This reduction in time could be due in part because the agreements can reduce the redundancy of coursework, drop the amount of time needed to earn a degree, and increase the quality of time spent in a classroom during high school and college (King & West, 2009). Additionally, articulation agreements could permit QRS High School and the local college faculty to work collectively to not only strengthen their relationships but also to provide advantageous connections, such as earning college credit during high school for course work (King & West, 2009; Montague, 2012). Articulation agreements can be beneficial for both high schools and colleges.

Communication between high school instructors and college professors could assist teachers in realizing there is a major discrepancy between the perceptions of high school and college teachers in terms of college readiness. ACT (2009a) conducted a study showing a discrepancy in the views of teachers. High school instructors consistently believe they have prepared their students for college. In some cases, that number is greater than 90%. The corresponding postsecondary professors have opposite feelings. Typically, fewer than 30% of professors believe students come to college prepared. For example, Jensen and Moore (2008) noted grade inflation takes place in high school, thus yielding students who are underprepared for the rigors college. Similarly, Schombert (2010) reported grade inflation in introductory astronomy due to deficient skills. Jensen and Moore (2008) recommended collaboration between high school teachers and college professors so they could work together to produce a high school curriculum that prepares students for their college science courses. According to ACT benchmarks and college readiness standards, taking the ACT allows students to assess if they are ready for the postsecondary education system (ACT 2008, 2010a, 2010b). Furthermore, an articulation agreement between QRS High School and the local community college could act as one assessment of the science curriculum and help bridge discrepancies.

Tests such as the ACT or SAT, coupled with a high school GPA, can have a major impact in the admission of a student to a college or university. Higher learning facilities use scores to assess the possible future academic success of potential students (ACT, 2008, 2010a, 2010b; Sawyer, 2010). Colleges use a combination of an ACT composite score and high school grade point average (GPA) with the expectation of providing an accurate account of a student’s expected academic achievement in his or her first year of college (ACT 2008, 2009, 2012). Knowing this information, increasing science skills at QRS High School is essential so students can meet college readiness standards while simultaneously preparing for postsecondary education. Articulation agreements between local high schools and colleges could help increase the attainment of science skills. This would be a suitable way to increase preparedness for college.

The science department at QRS High School must find a way to implement a constructive reform to the curriculum to enhance student achievement, so students obtain the science skills they are lacking. A paradigm such as the one presented, as well as the addition to professional literature on the use of inquiry in the classroom, provides a parameter to affect social change.

Implications

Science skill achievement is fundamental for students to be successful in the educational system and their future careers. For QRS High School, the school has been trailing the state and nation in terms of scientific achievement. Despite the struggles occurring in QRS School District, the school must be proactive and produce an ambitious strategy to improve science scores (Simpson, 2009), and the school district needs to create a specific set of educational goals for science students, kindergarten through 12th grade (Bolden, 2012), starting at the high school. The district can use state and national standards to set goals for each grade level. Based upon results from the data collected, the science department can determine classroom level factors that may be hindering the attainment of science skills. From this information, the department can decide possible directions for curriculum revisions. Using inquiry based strategies, such as those mentioned in the *National Science Education Standards* (National Research Council, 1996) definition and the results from collected data, the envisioned project for this study was an evaluation report for the school district to aid in the production of a new viable curriculum for each of the science courses at the high school. Future work could include the entire QRS School District's science program. Teachers can use the concepts and skills assessed during the ACT and strategically position them in applications employed in the classroom to increase science skills and achievement.

Summary

QRS High School must be proactive to increase the science skills base of students. Many children in this rural Midwestern town do not come from affluent families. Children living in poverty in the county rose 6.4% in just 8 years (Office of Social and Economic Data Analysis, 2011). While background data showed only a small number of students from QRS High School are prepared to take science in college (ACT, 2011a, 2011b), there is potential to increase this number. Students must have the self-discipline and dedication to prepare for college or the workforce so they have the skills to come back as change agents to help alter the dynamics of the town.

Research into the local achievement gap of science skills revealed pertinent information to assist in the alleviation of this particular issue. The research revealed the following: (a) testing and assessment concerns in science, such as teaching to a state test instead of utilizing a smaller number of concepts and assessing those concepts through various techniques; (b) local, state, national, and international competitiveness to succeed in science; (c) ideals of great theorists could help improve science skills; (d) creating a possible inquiry based curriculum would be beneficial and; (e) alternative classroom methods, increased rigor of coursework, and collaboration within the department and with the local college could each prove to be advantageous for scientific achievement. Each of these items assists in providing a comprehensive action plan to increase science skills at QRS High School through a proactive approach.

Section 2 of this project study discusses the methodology. The section includes such information as what type of research design is appropriate for a study, sample sizes, protection of participants, and treatment of each participant with dignity. I conducted a needs assessment of the science department's curriculum at QRS High School and created objectives, with benchmarks, to help guide the evaluation. The instrumentations employed included the following: a review of previous students' ACT scores, a survey given to the nine science teachers called the ISIS, a curriculum review of ACT science college readiness standards from a curriculum review worksheets workbook, and an interview. The treatment of participants throughout the study was in accordance with the code of conduct for human participants. Other material presented in Section 2 includes assumptions, limitations, scope, and delimitations of the study. Section 3 discusses the actual project, and Section 4 reflects on the project and draws conclusions.

Section 2: The Methodology

Introduction

This section addresses the use of an explanatory mixed methods program evaluation. The section contains multiple segments clarifying the description and justification of a mixed methods program evaluation, the use of an explanatory mixed methods design, the types of data collected, the rationale of employing an objectives based program evaluation, the overall evaluation goals, the setting and sample, data sequence, data analysis description, findings, the protection of participants, and the limitations of the evaluation.

The methodology section details quantitative and qualitative data collection and the analysis of data in QRS High School. A sequential explanatory mixed methods program evaluation helped determine deficient areas in the current science curriculum. The mixing of data in a sequential explanatory mixed methods design occurs after analysis of quantitative data as it advises the path of qualitative data (Creswell, 2008, 2009; Fetters, Curry, & Creswell, 2013; Lodico et al.,2013; Yoshikawa, Weisner, Kalil, & Way, 2013). Accordingly, quantitative data were collected in Phase 1. Phase 1 data included ACT background statistics from 2007 to 2011, presenting school, state, and national level data (no individual student records); individual past student ACT scores from 2008 to 2013; a curriculum check of ACT science college readiness standards, which are skills assessed by the ACT; and 22 classroom-level inquiry based practices in science as measured on the ISIS. Phase 2 data, the qualitative component consisted of individual interviews. According to Creswell (2009) and Fetters et al. (2013), interviews help interpret the quantitative data. Additionally, Yin (2011) stated that qualitative research helps provide an individual's perspective in to research.

Mixed Methods Justification

The design of this study involved mixed methods research. Mixed methods allow a researcher to use quantitative and qualitative data, providing both answers and understanding for research questions (Fetters et al., 2013; Ivankova, Creswell, & Stick, 2006). In particular, this study utilized an explanatory design in which Phase 1 data collection took place first and then Phase 2 data collection (Lodico et al., 2010; Yoshikawa et al., 2013). The advantage of this research approach to determine the impact of the science curriculum in QRS High School remained with the ability to not only report deficiencies in the science curriculum but also to describe teachers' viewpoint of those deficiencies. For instance, Lodico et al. (2010) and Yoshikawa et al. (2013) both discussed mixed methods research as an approach combining the strengths of quantitative and qualitative research, providing an effective case through both measurement and a detailed account.

Phase 1: Quantitative methodology. During this needs assessment, I employed explanatory quantitative research. This research method is useful when attempting to determine connections between variables (Chen, 2012). The explanatory research design that this study applied examined the comparison of variables (Creswell, 2008; Pickard, 2013). The problem of this study was the lack of science skills. However, there was no identification of a cause (Chen, 2012). The first research question was seeking the variance of the proportions between science ACT scores and science college readiness standards taught in the classroom. For example, will an average score of 20 indicate that the average score range taught at QRS High School is the 20-23 range? Essentially, ACT scores should be similar to the score range of college readiness standards taught in science classrooms. The second research question was looking for the variance of the proportions between ACT scores and scientific inquiry. This was an attempt to determine any inconsistencies between inquiry usage and the ACT data. For the second research question, low ACT scores should equate to less science inquiry in the classroom. The advantage of explanatory research is the identification of a connection. More specifically, the use of *t*-tests and bivariate tests allowed for the comparison of the means and provided statistical inference for the Phase 1 data (Chen, 2012).

Phase 2: Qualitative Methodology. For Phase 2 of the evaluation, I utilized qualitative measures to understand Phase 1 data. Qualitative measures provide subjective, yet critical, meaning to a study (Hesse-Biber, 2010; Merriam, 2009). Quantitative research alone could not provide insight into the problem of this study, low science skill acquisition. Therefore, this study asked for the science teachers' perspectives concerning inquiry science and issues within the department that may be hindering skill acquisition. Case study research is deemed appropriate for program evaluations, and it provides the opportunity to develop an understanding of a single unit, or group (Lodico et al., 2010; Merriam, 2009). Case study permitted coverage of contextual conditions and provided the view of the participants (Yin, 2011) from their natural school setting. While other research designs were plausible, this study did not need life experiences such as those presented in phenomenological studies, the cultural perspective of ethnographic research, or the depth of description found in narrative research (Lodico et al., 2010; Yin, 2011). Furthermore, according to Lodico et al. (2010), case studies are interpretive research in which personal experiences can assist by providing meaning while investigating a process; Hesse-Biber (2010) stated the strong connection between researcher and participants through the practice of empathy, which provided an in-depth perspective of the lack of science skill acquisition in this study.

Program Evaluation

In an effort to demonstrate an inconsistency within QRS High School, this project study involved conducting a program evaluation. The justification is that an evaluation has a specific purpose, or outcome to improve, or change, a program quickly and (Lodico et al., 2010). In this project study, the purpose of the program evaluation was to assess the effectiveness of the science curriculum in QRS High School. Researchers use program evaluation to make decisions regarding the future of a program, whereas applied research is for the expansion of knowledge for professionals in that field of study (Creswell, 2008; Mertens, & Hesse-Biber, 2013; Spaulding, 2008). Future decisions in this instance involve possible alterations in the science curriculum to improve potential students' science skills base. Any alterations in the curriculum would result from the science department working to assess whether the curriculum and practices align with desired outcomes. Data collected during the program evaluation worked cohesively to create a comprehensive action plan to help decide which instructional strategies to use in the classroom, which factors are hindering success, and what will help increase scientific skills at QRS High School.

With a research problem such as the achievement gap for science skills, an explanatory mixed methods program evaluation was the most suitable choice for this project study. I collected past student ACT data, gave a curriculum review worksheet to each teacher in the science department, and gave a survey to determine classroom-level factors that have an influence on the acquisition of science skills. Then, I analyzed the data. After the quantitative data analysis, I conducted electronic interviews to determine how the science teachers describe their impact on student acquisition of science skills. The results of the data assisted in providing recommendations to help increase the science skills acquired in QRS High School.

Needs assessment. At the start of this study, the high school had a science curriculum in place. However, background data revealed a gap in practice within the school. Therefore, I conducted an objective-based program evaluation, specifically a needs assessment, of the science curriculum for deficiencies in the use of inquiry techniques and ACT assessment skills. A needs assessment estimates deficiencies in a program (Royse, Badger, & Staton-Tindall, 2009) that are relevant to the needs of the organization at that time (National Oceanic and Atmospheric Administration [NOAA] Coastal Services Center, 2013). Furthermore, the findings of a needs assessment cannot be generalized but are generally applicable at the community level (Altschuld, & Kumar, 2010; Royse et al., 2009). The NOAA (2013) discussed a 12-step process for conducting a needs assessment and Royse et al. (2009) categorizes the program evaluation process into three phases: pre-assessment, assessment, and post-assessment. Figure 1 provides a visual of the itemization of the three stages within the 12-step process.

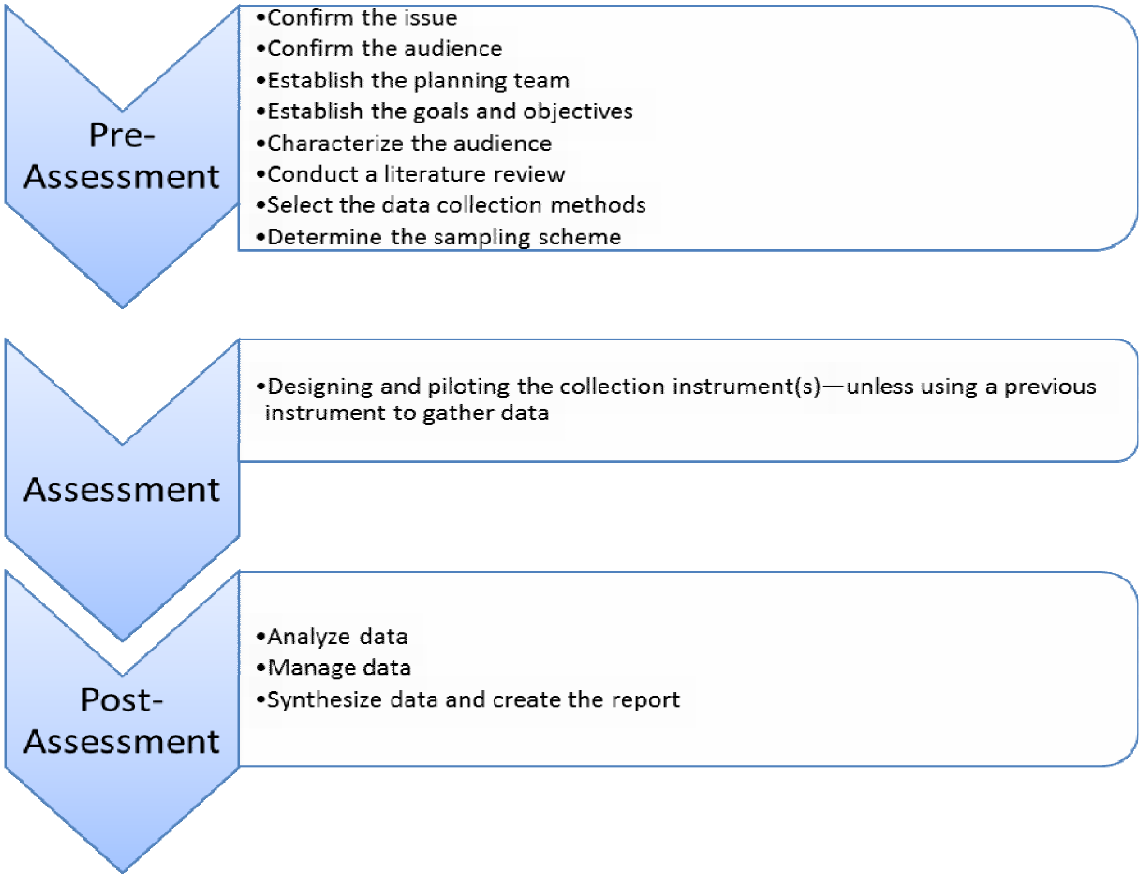


Figure 1. Itemization of a three stage, 12-step program assessment

Organizations utilize needs assessments when, as reported by multiple researchers (i.e., Altschuld & Kumar, 2010; Mertens & Wilson, 2012; NOAA, 2013; Royse et al., 2009), company efforts can fill the need and when the evaluator is in the beginning stages of the planning process. In this study, the need was an effective science curriculum: a curriculum that prepares high school students for the next phase of their lives.

Objectives for the needs assessment. During a needs assessment, the evaluator must identify clear goals and objectives. Therefore, written objectives consisting of each ACT science college readiness standard (see Appendix C and Appendix D) helped guide the science department, and specific benchmarks provided future quantifiable goals for teachers to use in their classes (Lodico et al., 2006, 2010; Patel, 2010; Spaulding, 2008). The overall goal was to assess the effectiveness of the science curriculum at QRS High School.

During the pre-assessment phase of a needs assessment, evaluators may develop a matrix (Lodico et al., 2010), or gates (Royse et al., 2009) to organize information. The matrix for this project study provides such information as the general program objectives and types of evaluations used. Table 2 provides this information.

Table 2

Evaluation Matrix for QRS High School Science Teachers

Overall Program Objective	Stakeholder Group	Evaluation Tool	Type of Data	Timeline for Data Collection
Document past high school students science ACT scores.	Teachers: grades 9-12 Principal	Student data records	Summative	Occurs before the curriculum evaluation
Document Science College Readiness Standards that are taught in each science course at QRS High School	Students: grades 9-12 Parents Teachers: grades 9-12 Principal	Teacher survey	Summative	Occurs during the curriculum evaluation
Document the frequency QRS High School science teachers expose their students to scientific inquiry	Students: grades 9-12 Parents Teachers: grades 9-12 Principal	Teacher survey	Summative	Occurs after the curriculum evaluation
Document individual teacher perspectives regarding their impact on student acquisition of science skills at QRS High School	Teachers: grades 9-12 Principal	Teacher interviews	Summative	Occurs after the analysis of quantitative data

Note. Adapted from *Methods in educational research: from theory to practice* (p. 376), by M. G. Lodico, D. T. Spaulding, and K. H. Voegtle, 2006, San Francisco, CA: Jossey-Bass.

One of the steps in a needs assessment is to create objectives and corresponding benchmarks, or goals, (Altschuld & Kumar, 2010; NOAA, 2013) which help guide future data collections and changes to a program (Lodico et al., 2010). This evaluation included the following overall program objectives and benchmarks as they relate to the achievement of science students.

1. Program objective: Document past high school science students' science ACT scores.

Benchmark: not necessary, as this was past student data.

2. Program objective: Document science college readiness standards taught in each science course at QRS High School.

Benchmark: QRS High School will make necessary changes in the science curriculum to cover all Science College Readiness Standards in score range indicators 13-15, 16-19, and 20-23 as, according to ACT (2013), a score of 23 on the science portion of the ACT is the college readiness benchmark. The QRS High School science department will also increase coverage of readiness standards in score range indicators 24-27, 28-32, and 33-36 as deemed appropriate by the department.

3. Program objective: Document the extent to which science teachers at QRS High School expose their students to scientific inquiry.

Benchmark: QRS High School will make necessary changes in the classroom to increase the frequency that teachers apply scientific inquiry in the classroom; future surveys can document the success of this benchmark.

4. Program objective: Document individual teacher perspectives regarding their impact on student acquisition of science skills.

Benchmark: not necessary.

The design of the program objectives and benchmarks was to be proactive within the department and anticipate desired change.

Setting and Sample/Participants

ACT Data

The population for ACT data retrieval entailed all previous students from QRS High School between the 2008-2009 school year (this was the first year of the computer system) and the 2012-2013 school year. Nonprobability sampling was appropriate in this study, as an in-depth look into past ACT data at QRS High School was desired and the data did not need to generalize to the entire population (Creswell, 2008; Martin & Bridgmon, 2012). I utilized a convenience sample (Lodico, et al., 2010) consisting of any former student who had ACT data in the QRS High School computer system. The specific sample number included 469 students. However, there were 1,339 students in the population and 850 in the possible sample records. The possible sample number included students taking the ACT multiple times so duplicates were deleted. Using a power analysis by Lenth (2009), the sample size needed to be at least 297 students with a population of 1,300, a confidence level of 95%, and a confidence interval of +-5. This number rose to 586 when the confidence interval was +-3.

Teacher Data

Participants in the program evaluation consisted of educators who teach science at QRS High School. There were nine possible participants, with a median age of 42.8 years. Six teachers were regular education teachers and three were special-education teachers. In respect to the sample size and population for the program evaluation portion of this study, Table 3 displays descriptive data.

Table 3

Descriptive Data of Participants

Gender	Age
Female	38
Female	41
Male	33
Female	63
Female	22
Female	35
Male	54
Female	48
Female	51

Note. All participants were science teachers in the same high school.

The teacher sample for this study was from a larger population of all teachers in QRS School District in which there is only one high school. The sample group was a convenience sample because only a natural, easily accessible, group was available (Mertens & Wilson, 2012). I did not randomly select the science teachers. Rather, they were a cohort in the high school, and this study involved science skills. The sample size of nine was acceptable in this case because “the study must be of adequate size, relative to the goals of the study” (Lenth, 2001, p. 187), which was to document the goals listed in Table 2 for only QRS High School. Furthermore, many researchers may choose to study a single unit, such as an organization (Yin, 2011) or a portion of the organization, as with this study, thereby limiting the number of participants to those available. More specifically, a needs assessment cannot be generalized, but the results are generally applicable for the local community (Altschuld, & Kumar, 2010; NOAA, 2013; and Royse et al., 2009). Furthermore, I did not expect the qualitative research of the study to generalize to a larger population (Lodico et al., 2010). Because this sample contained human subjects, I was obligated, as discussed by Fink (2009), to maintain the following: a proper code of ethics, the privacy of the participants, and confidentiality according to federal code.

Instrumentation and Materials

Data Collection

The data collection and subsequent analysis for this project study stemmed from the research questions. There were three research questions for this project study. The first two research questions were quantitative and the third question was qualitative. The first research question was seeking the variance of the proportions between science ACT scores and the science college readiness standards taught in the classroom. The second research question was looking for the variance of the proportions between ACT scores and scientific inquiry. The third research question concerned the viewpoints of science teachers at QRS High School. The Phase 1 and Phase 2 data collections and the analysis worked collectively to produce results. The advantage of an explanatory mixed methods design was having clearly defined quantitative and qualitative segments providing the ability to choose the level of interaction between the segments (Creswell, 2008). The integration of data could be through the supportive nature of the qualitative interview through which, according to Creswell (2008) and Yoshikawa et al. (2013), understanding of the quantitative data occurs.

The use of an explanatory mixed methods design allowed for the integration of data into the deficiencies in the science curriculum by utilizing the following resources: (a) previous students' ACT records from 2008-2013, (b) ACT science college readiness standards from the curriculum review worksheets workbook, (c) the ISIS, (d) a copy of each science course's curriculum (for teachers to examine their own curriculums), (e) copies of the instrumentations for each science teacher to answer the questions, (f) a computer to log data, (g) the SPSS analysis program, and (h) a set of interview questions. The needs assessment in this project study involved the examination of the science curriculum to determine deficient areas at QRS High School as it pertained to scientific skills.

Phase 1: Quantitative Instruments

ACT archival data. One portion of data collection for this program evaluation consisted of compiling science ACT scores for past graduates from 2008 to 2013. During the archival data collection, which was through the high school software program, I physically looked at each file and entered each student's science ACT scores. I knew it was essential to have a procedure in place when looking through each file. However, research failed to produce a preferred method therefore I created my own, two-tiered, system to eliminate entries for students who took the ACT multiple times or obtained the same composite score. The system to eliminate duplicates included taking the highest composite score first and then taking the latest date (December versus October) if the student had multiple identical composite scores. The reasoning behind taking the later date involved the inference that the student should have covered more ACT topics, but also to be consistent so that I was not looking at individual science scores. This procedure reduced research bias to make the science scores appear higher. Furthermore, if all entries were included in the data, the data would not be a true representation of individual student scores, for the mean could have been higher or lower depending on the scores of any deleted entries. After completing this two-tiered system, there were 469 entries for analysis: 251 females and 218 males (See Appendix F). To ensure data were exhaustive, I also entered each student's gender and his or her math, reading, English, and composite scores.

In terms of the validity of the ACT and concepts assessed in science (discussed in Section 1), the ACT has been widely accepted for more than 50 years. Students have 35 minutes to answer 40 questions. In addition to concepts addressed from a research perspective, studies conducted by ACT (2008) and Furgol, Fina, and Welch (2011) supported the validity of ACT scores and the scores as a reliable source to predict college readiness, college enrollment status, academic proficiency, and first-year college success.

Curriculum review. The title of the curriculum review for each course is the Curriculum review worksheets workbook: ACT science college readiness standards (see

Appendix D). The purpose of the worksheets is to act as a guide while inspecting a school's curriculum to determine compatibility with items assessed during the ACT (ACT, 2006). The workbook consists of a series of 47 standards covered during the science ACT, and the standards are distributed for score ranges including 13-15, 16-19, 20-23, 24-27, 28-32, and 33-36. For each of the 47 standards, there were three questions to answer:

1. Is the standard included in the science curriculum?
2. What course first introduces the standard?
3. In what course should the students be proficient at the standard? (ACT, 2006).

Every teacher had the curriculum review worksheets to complete for each course taught, and approximate time to complete was 30 minutes per course (raw data appears in Appendix E). By having each teacher complete the worksheets, the science department could determine deficiencies, in terms of college readiness standards, within the curriculum. Having data for each course allowed for not only comparisons between science courses but also within an individual course taught by multiple teachers. For example, biology is a course taught by multiple science teachers. Having each teacher fill out the curriculum review permitted a comparison of which standards each instructor teaches. If the data revealed that one teacher is not covering a standard that other teachers are covering in class, that instructor can make appropriate adjustments to his or her curriculum. Completing the worksheets, according to ACT (2006), would help the science department focus on instructional needs, identify instructional goals, and compare curriculum content and expectations (p. 1).

Inquiry science implementation scale (ISIS). The title of the survey is the ISIS. The purpose of this survey is to examine inquiry based science programs. This study reviewed the implementation of inquiry based skills (Brandon et al., 2009). The survey consists of 22 inquiry-related questions (see Appendix G and Appendix H) to determine the implementation, and frequency, of inquiry techniques by science teachers in the classroom. QRS High School can use the results to identify items that help or hinder the amount of inquiry applied in science classrooms (Brandon et al., 2009). The results facilitated the direction of the needs assessment.

Participants needed between 10 to 15 minutes to complete the survey. All survey items used a typical Likert-type 5-point scale: (1) *Almost Never*, (2) *Seldom*, (3) *Sometimes*, (4) *Often*, and (5) *Almost Always*. The high school can use the results to determine the frequency of inquiry science usage (raw data appears in Appendix I). Scores ranging mostly at 1 or 2 indicate an opportunity for improvement (Brandon et al., 2009). The intended application of the findings for this project study is to provide QRS High School with data during the introduction phase of the ISIS. To address content validity concerns, Brandon et al. (2009) worked for several months with colleagues considered experts in creating models of inquiry science. The researchers conducted pilot tests, had an advisory board, and conducted a test-retest study. The result was the ISIS coupled with a five-item log (only to collect validity data for the study) for science teachers to complete after each inquiry based lesson. The mean was 3.8 (*SD* = 3.4; range

= 16) and the coefficient α for the five-item log was 0.72. As a further measure for validity, Brandon et al., calculated the correlation between the five-item log. The correlation was 0.63 (significant at the 0.01 level). Reliability measures included test-retest and internal consistency. For the 111 participants who completed the ISIS twice, the Cronbach's alpha after the first administration was 0.87 and 0.89 after the second round (Brandon et al., 2009), demonstrating the reliability of the ISIS. Overall, the ISIS provides a quantitative measure for classroom-level scientific inquiry implementation.

Phase 2: Qualitative Sequence

In accordance with a sequential mixed methods explanatory design, I conducted the Phase 2 data collection consisting of interviews with each of the science teachers after the analysis of Phase 1 data. The interview consisted of nine questions (see Appendix J and Appendix K), with an estimated completion time of 10-30 minutes as it was an electronic interview. I chose an electronic format for the interview, as it would give participants flexibility to answer the questions at their convenience and would eliminate irrelevant conversations (Patel, 2010). Qualitative data is interpretive, using inductive methods to provide concrete understanding of the data (Yin 2011) through the voice of participants.

Data Analysis

Phase 1: Quantitative Analysis

The data collection for Phase 1 consisted of archival ACT data, a 47-item ACT workbook, and a 22-item ISIS. The ISIS used a 5-point Likert scale, which is a quasi-interval scale according to Chen (2012) and Pickard (2013). Sherwood (2010) utilized staff surveys to gather input for a program evaluation. Surveys are useful during program evaluations and other policy decisions if the information needed should come from participants (Fink, 2009). As such, I asked participants to complete the survey and workbook review. I emailed the consent form to participants, and included links to submit answers for each instrument anonymously through a website called Survey Monkey. I asked each teacher to examine his or her course(s) to check for the inclusion of inquiry techniques and the standards assessed during the ACT. Concurrent with teacher participants completing this data, I input the archival ACT data into a data analysis program, SPSS. Then, once the participants returned the completed survey and workbook, I added the ACT workbook data and the ISIS data to the analysis program. I obtained a factor analysis and descriptive statistics based on numbers such as general tendencies and the range of scores for all three sets of data (Creswell, 2008). Additional data analysis of the individual data sets included a one-sample *t* test to evaluate the variance between data sets (IBM, 2012). I used a constant, or test value, for each data set, to represent a neutral point. The typical neutral point is 70% (IBM, 2012). However, I chose a 60% proportion as the neutral point because that is the college readiness standard percentage, 23 out of a 36. The neutral point numbers equated to 23 for ACT scores, 3.0 for the ISIS, and 28 for the ACT workbook. In essence, the analysis determined if participants scored higher than a 60% proportion on each respective scale. To describe the science standards, numbers from 1 to 6 indicated the score range. Numbers from 1 to 5 indicated the ISIS data score. A numerical value indicated the science ACT score. The scale applied numbers such as 19, 20, and 21. Additionally, I completed a binomial test for each data set to evaluate the proportions (IBM, 2012). I conducted a simplified gap analysis of the ACT workbook data. Essentially, the analysis of the ACT workbook determined deficient standards--standards not in the science curriculum. Determining the proportions through one-sample *t* tests and binomial tests, and completing the gap analysis, provided a strong foundation for making recommendations of what content specific areas to address.

Archival ACT data analysis. I entered Archival ACT data in the statistical program SPSS (IBM, 2012). Descriptive statistics revealed a mean science average slightly higher than the composite score, 0.111, with the median and mode showing no variation (see Table 4). Once descriptive statistics defined ACT data, a one-sample *t* test was computed.

Table 4

Descriptive Statistics for Archival ACT Data

	ACT English	ACT Mathematics	ACT Reading	ACT Science	ACT Composite Score
Mean	20.640	20.633	21.704	21.337	21.226
Median	21.000	20.000	21.000	21.000	21.000
Mode	20.0	17.0	21.0	20.0	20.0

Note. N =469.

I conducted the additional analysis of a one-sample *t* test (see Table 5; output data can be found in Appendix M) on ACT scores to evaluate the mean of the test variable, ACT scores at QRS High School, for a significant difference from the constant, the ACT science readiness standard of 23, set by ACT (IBM, 2012).

Table 5

One Sample Statistics for Science and Composite ACT Scores

	Mean	Std. Deviation	Std. Error Mean
ACTScience	21.337	4.1445	.1914
ACTCompositeScore	21.226	4.2144	.1946

Note. N =469.

The sample mean of 21.34 (*SD* = 4.14) was significantly different from 23, *t*(468) = -8.69, *p* = .00. The 95% confidence interval mean for the science ACT scores ranged from 20.96 to 21.71. Therefore, the ACT test population at QRS High School has scores that are slightly below the science college readiness standards set forth by ACT.

A supplementary analysis of ACT scores by gender showed males scored slightly higher in science and on the composite scores. The frequency numbers indicate a mode of 21 for males, 35 students, and 20 for females, 44 students. The median was 22 for males and 20 for females. Numbers for the composite score are similar, in which the median is 21 for both males and females. However, these numbers are below the ACT college readiness standard in science (ACT, 2012). A visual representation of this information can be found in Appendix M. Furthermore, frequency data verified that 63.1% of all students did not meet the college readiness standard in science. In addition to this data, 73.8% of the students scored a 23 or less on the composite score.

ACT workbook data analysis. The original ACT workbook data participants completed contained the 47 items assessed during the ACT (ACT, 2006). The participants were asked to fill out the survey for each course taught (raw data can be found in Appendix E). There were three sub-questions per item. A data table showing the percentage for individual course data, found in Appendix M, provides an abridged version for the percentage of ACT items participants cover in each score category. For instance, a participant who covers 44.4% of the 20-23 score category incorporates four of the nine items in his or her curriculum. The ACT workbook data illustrated a significant decline in coverage between the 20-23 and 24-28 score categories. ACT workbook data also revealed an inconsistency within courses taught by multiple teachers. More specifically, physical science courses do not cover the same assessed items in five of the six score categories; in the top four score categories there is as much as a 55 to 87.5% difference. Biology courses experience the same variation in coverage, although consistency begins to diminish at the 24-27 score category.

Table 6

One Sample Statistics for ACT Workbook Standards

	N	Sig. (2-tailed)	Mean	Std. Deviation	Std. Error Mean
ACT Standards	17	.788	27.3529	9.73358	2.36074

Note. Some teachers have multiple courses. There are 47 standards total.

Once descriptive statistics (Table 6) identified the average number of standards covered in the science curriculum, a one-sample *t* test evaluated the mean of the test variable for a significant difference from the constant. The mean was the number of standards included in the science curriculum, 27 standards, at QRS High School and the constant was 28 standards, approximately 60% of the standards (IBM, 2012). Output data can be found in Appendix M. The sample mean of 27.35 (SD = 9.73) was not significantly different from 28, $t(16) = -2.74$, $p = .788$. The 95% confidence interval mean for ACT standard usage ranged from 22.35 to 32.39. This indicates that the science teachers at QRS High School do not score significantly different from covering 60% of the standards covered on the ACT, meaning the teachers are teaching approximately 60% of the 47 standards.

ISIS data analysis. ISIS provided data entailing science teachers' inquiry usage in the classroom. Data were recorded in to SPSS (IBM, 2012). Descriptive statistics revealed a mean of 3.6 on a 5-point scale (see Appendix M). This indicates an average level of inquiry usage in the school's science classrooms (Brandon et al., 2009). Additional analysis of descriptive statistics (see Appendix M) revealed an average variance of .17 and a standard deviation of .41. The skewness was negatively distributed, -.59, signifying the majority of scores fall at the higher end of the 5-point scale. Frequency data determined (see Figure 2) 44% of the teachers at QRS High School are using inquiry *sometimes to often*, which equates to anywhere from the low end of a 3, 30%, to the high end of a 4, 74%, on the 5-point scale.

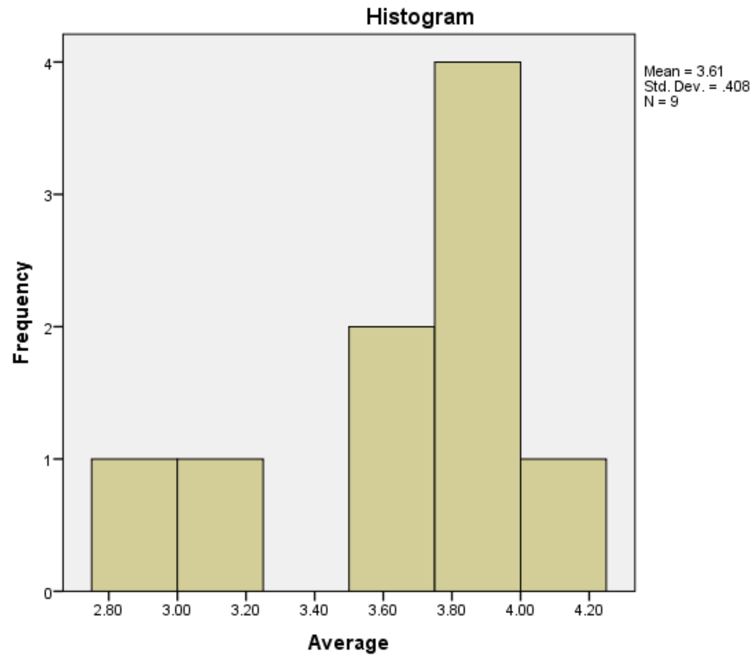


Figure 2. Histogram showing teacher average frequency of inquiry usage on a 5-point scale. Note. N = 9.

After descriptive and frequency statistics identified the average level of inquiry usage on the ISIS scale, 3.6 out of 5, a one-sample *t* test evaluated the mean of the test variable, inquiry usage, for a significant difference from the constant, 3.0 (60%, or a score of 66 out of 110 for individuals) on the ISIS scale (IBM, 2012). The output data can be found in Appendix M. The sample mean of 3.61 (SD = .41) was significantly different from 3.0, $t(8) = 4.50$, $p = .00$. The 95% confidence interval mean for ISIS inquiry usage ranged from 3.30 to 3.92. This indicates that the science teachers at QRS High School have scores where they include at least 60% of the inquiry methods on the ISIS, thus, according to Brandon et al. (2009), improvement is not required.

Phase 2: Qualitative Analysis

As stated earlier, I employed case study research for the analysis of Phase 2 data. I wanted to examine a contemporary single unit without controlling the behavior of the participants or altering the materials, which were the interview questions (Yin, 2014). The Phase 2 data for this study consisted of interviewing each participant (see Appendix K). Once each participant returned the electronic interview anonymously through Survey Monkey, I followed a similar procedure as Yin (2011) for the analysis of qualitative data, which includes compiling, disassembling, reassembling, interpreting, and then concluding. Case study research was suitable because the high school science teachers are a unit and this study sought to gain insight within this group (Lodico et al, 2010; Merriam, 2009; Yin, 2011, 2014). I compiled Phase 2 data that paralleled Phase 1 data (Yin, 2011) in that the data provided understanding as to why the science teachers may not be employing all inquiry concepts and ACT standards in the classroom. Once I compiled data, I disassembled the data by obtaining a perception of both individual and the group's answers and then reassembled the data using an array design which refines the data to look for descriptions and major themes (Yin, 2011). The next step was to interpret and layer the themes to produce conclusions, and a call for action (Yin, 2011). Detailed descriptions of the data provided understanding and, in this case, involved an inquiry in to the educational process at QRS High School (Lodico et al., 2010). The descriptions and documentation of data provided transparency to the study so others may read and understand (Yin, 2011). Although credibility of the interviews through member checking, asking each participant to establish the accuracy of the outcomes (Creswell, 2008; Merriam, 2009), is still valuable when participants answer electronically, I chose to forgo member checking to maintain complete anonymity. Dependability, which parallels reliability, was met through the ability to track the data collection and analysis from the interview, initial analysis, coding, development, and layering of the themes providing detailed accounts (Lodico et al. 2010). Adherence to the evidence permits researchers to base any conclusion, or a call for action, on the analyzed data (Yin, 2011; 2014). Transferability in this research study refers to other small, rural high schools having the ability to use the research, as judged by the other school. As such, it is important, according to Lodico et al. (2010) and Yin (2011), to provide rich descriptions and detailed accounts so other schools have the ability to make a suitable decision concerning the use of this research.

Codes and themes. The interview questions (see Appendix K) allowed participants to voice their opinions about scientific inquiry, as well as issues within the science department. The format for the interview and the analysis followed a similar protocol as suggested by Yin (2011) where data were collected, compiled, disassembled, reassembled, and interpreted so conclusions could be generated. Due to the online nature of the interviews, responses were already recorded and I did not need an *ice-breaker* question. When all participants completed the interview, I read each one. Next, I organized the data by interview question so I could view all responses to individual questions simultaneously. There were nine questions with eight responses to each question. After organizing the data, I read through all answers to obtain an initial perception. My preliminary view was that the science teachers have a straightforward sense of inquiry but slightly different visions on what teachers and students need to know for effective inquiry lessons, which is not necessarily negative but does provide understanding as to why teachers of the same subject, i.e. physical science or biology, are not teaching the same inquiry concepts and ACT standards. As for issues within the department, limitations out of the department's control surface more often than not. These issues could inhibit collaboration time to correct discrepancies within the department.

Subsequent to my initial insight, I began the disassembling process through the voice of the participants (Yin, 2011). I highlighted repetitive words and made marginal comments while reading the responses to each question. I produced six codes from the nine questions: definition, effectiveness, knowledge, application, issues, and solutions. The first four codes involved scientific inquiry and the last two codes detailed setbacks within the department. While coding, I produced the following themes (listed in Table 7) for each interview question. See Appendix L for the expanded list.

Table 7

Interview Question Themes

Question	Theme
1	active student learning
2	application of skills
3	structured lesson that appears unstructured
4	student application
5	time
6	time and money
7	collective external hindrance
8	collective internal solutions
9	impending opportunities

Note. $N = 8$.

Assumptions

I made assumptions in regards to methodology, background data, quantitative measures, and qualitative measures. Presumed assumptions in the mixed methods methodology included the following: Phase 1 data emphasize objectivity and Phase 2 data provide an understanding of the research questions (Hesse-Biber, 2010; Mertens & Hesse-Biber, 2013). Presumed information about all ACT background and archival data in this study included that (a) all QRS High School students took the ACT in the same testing center, (b) all students had the same testing materials when each took the ACT (i.e. pencils, calculators), (c) all students took the ACT during their senior year or for a final time during their senior year of high school, (d) all students understood the directions, and (e) all students made their best effort. In reference to the ISIS survey items and ACT workbook items, assumptions included the following: all teachers answered honestly and understood the directions, the ISIS accurately measures inquiry science implementation (Brandon et al. 2009), and the ACT workbook accurately measures the College Readiness Standards covered during the ACT (ACT, 2006). Concerning qualitative interview questions, assumptions included that all teachers answered honestly and understood the questions.

Limitations

This project study took place in a small rural school district in the Midwest. The study was limited to the number of past graduates who took the ACT between the 2008-2009 school year and the 2012-2013 school year and the number of high school science teachers in the district. As such, the findings of the study can only generalize within the study district (Patel, 2010; Royse et al., 2009). I conducted this study as an internal evaluator, and I have a professional relationship with each of the science teachers in the high school (Mertens & Hesse-Biber, 2013). The teachers may have felt the need to alter results so as not to hurt anyone's feelings or so there were no negative outcomes. Likewise, the teachers may not have understood every item on the survey or the workbook and recorded a false answer. Additionally, the teachers may have chosen not to answer one or more of the interview questions. There was also a lack of baseline data for science skill achievement. I had to use 5-year archival ACT data trends to infer any associations. The school in this study did not have any previous data to help determine curricular needs.

Scope and Delimitations

The scope and boundaries for this study involved one rural Midwestern town's high school science teachers. More specifically, this study provided a platform for grade levels K-8 at one rural school district to revise their science curriculums utilizing the instruments in this study. The district could use the ISIS at the lower grade levels to include more inquiry (Brandon et al., 2009), while the ACT college readiness standard workbook could be used in grades 6 through 8 in an effort to improve science achievement (ACT, 2006). This study did not concentrate on such extraneous variables (Lodico et al., 2010) as the following: why students do not acquire science skills, factors other than science courses taken that affect a student's science achievement, individual teaching strategies, individual student abilities, and the amount of time each student devotes to his or her studies.

Limitations of the Evaluation

Although this study consisted of a mixed methods program evaluation, there were limitations of the evaluation. Limitations of this study consisted of the ability to generalize results, a large ACT sample size coupled with a small teacher sample size, and the quantitative instruments measuring different variables making it challenging to produce correlation statistics between instruments. According to Altschuld and Kumar, (2010) and Royse et al. (2009), studies involving a needs assessment cannot expect to generalize to a larger population but may have the ability to transfer at the community level. I was limited to the number of past students who took the ACT and by teachers in the high school who teach science. ACT data measures performance, the ISIS measures the frequency of inquiry techniques applied by teachers, and the ACT curriculum review measures the number of standards covered in the science curriculum. Although the teacher sample size was small, Lenth (2001, 2009) supported placing the science of the research before statistical numbers. Additionally, Martin and Bridgmon (2012) noted that *t*-distributions can work with any sample size. The design of a needs assessment is to identify deficiencies within a particular organization (NOAA, 2013; Royse et al., 2009). In regards to the needs assessment itself, this evaluation was about the need to initiate a program, not the effectiveness of the current curriculum.

Participants' Rights

According to the National Institutes of Health [NIH] (2012), studies must take the proper measures to protect participants. Therefore, I provided each participant with information regarding the purpose and goals of the study to make an informed decision about his or her participation. Additional material provided included the potential personal, social, physical, psychological, and economic risks (such as feelings that may arise upon the realization of what skills a teacher does not assess in a particular classroom) of the study. I informed Participants they could renounce their participation at any time during the study (Creswell, 2008, 2009; NIH, 2012). The most straightforward procedure for gaining access to each of the participants was a direct approach (Lodico et al, 2010). I have been a science teacher at QRS High School for 13 years. I do not hold an authoritative position over any participants but do have a professional relationship with each one. Therefore, I presented the proposed study and requested the participation of the science teachers during a science department meeting;

discussed the study; provided consent forms for each teacher to view; and reinforced that their answers would be anonymous, providing a high level of protection, as they would submit their answers via Survey Monkey through which I had no way to identify individual participants. Each of the teachers in this study received a consent form through email (see Appendix N) to sign prior to any involvement on their part. Additionally, any data collection must keep all ethical considerations in the forefront I followed a similar procedure as mentioned by Creswell (2008, 2009) and Yoshikawa et al. (2013) where I coded all data, with no identifying factors; kept the key separate from any data; and maintained each participant's rights throughout the study.

Role of the Researcher

The role and perspective of an evaluator is imperative when conducting research. Being an internal evaluator, I already had an established a working relationship with each participant and understood the dynamics of the setting (Lodico et al., 2010; Merriam, 2009). As such, I had to maintain adaptability in terms of possible experimenter bias--unintentional effects due to personal attributes. To remove reactive effects as a result of novelty, participants were not informed of the expected outcome of the study and the study addressed past practices, not future practices (Lodico et al., 2010). While maintaining a working relationship, I had to generate a research-based connection with participants. To help establish this connection, each participant received a consent form. The consent form defined the participant's role in the project to help create a productive research environment (Royse et al., 2009), allowing for a separation between work-related and research-related relationships. There could have been issues of response bias in which the responses on the survey given do not necessarily reflect the sample or population group (Creswell, 2008). The participants may not want their teaching to appear inadequate to the researcher, thereby altering their answers to survey and interview questions. However, the anonymous nature of the data should have alleviated this issue. While my relationship with each of the teachers could have affected the outcome of the data to produce positive results, this is not expected.

I had to perform a dual role in this study, for I teach four of the science courses taught at the high school. Therefore, I had to answer the ACT workbook questions and the ISIS survey. I electronically delivered, through email, each teacher the Phase 1 instruments and the Phase 2 questions. The email had a link to answer questions anonymously. I was not with the teachers while they completed each instrument. I analyzed the data and made recommendations based solely on the results. The interpretive Phase 2 results were able to provide understanding for the Phase 1 results.

Findings

Phase 1: Quantitative Findings: Comparison between Data Sets

In the research questions of this study I wanted to examine the variance between past student ACT scores and the number of ACT science standards or the amount of scientific inquiry in the curriculum at QRS High School. The ACT measures scientific inquiry concepts (ACT, 2013b), representing the importance of seeking a connection between data sets. This process proved to be more of a challenge than anticipated as there were not the same number of cases in any of the data sets, 469 ACT scores versus 9 teacher participants for ISIS and 17 responses for ACT workbook data. To explain further, SPSS would only analyze the first 9 cases in the comparison between ACT scores and ISIS scores and the first 15 cases in the comparison between ACT scores and ACT workbook data, thus rendering any analysis impractical. Additionally, individual ACT scores were not matched up to individual teachers (to maintain anonymity). Due to these two factors, I was unable to run Pearson *r* correlations, ANOVA, or ANCOVA analyses between data sets. Therefore, the most effective way to compare the data sets was to utilize proportion analyses.

To analyze Research Question 1, ACT scores and ACT workbook data, and Research Question 2 ACT scores and ISIS data, I computed *t*-tests to obtain the standard error of difference (Martin & Bridgmon, 2012) of the individual data sets and then tested the overall proportions by computing binomial tests (Martin & Bridgmon, 2012) in SPSS (IBM, 2012) so a comparison of the data from the corresponding research question could be made. Essentially, I calculated all three data sets with the same hypothesized test proportion, 50% of all subjects would score less than 60% on their given scale; these numbers equated to a score of 23 out of 36 on the science ACT, 3 out of 5 or 66 points out of a possible 110 on the ISIS scale, and 28 out of 47 ACT standards in the curriculum (output data can be found in Appendix M). According to McDonald (2009), "observed data are compared with the expected data, which are some kind of theoretical expectation" (para. 2). My theoretical expectation was that the final ACT score proportion should not be above the ISIS and ACT workbook proportions. Basically, this associates with the statement that most students should not be testing above what is covered in the curriculum.

Comparison of archival ACT data and ACT workbook data (research question 1). Research Question 1, what is the variation in the proportions of past student ACT scores and ACT Science College Readiness Standards covered in the science curriculum at QRS High School, was examined through *t* tests and binomial tests. The binomial tests for ACT scores and ACT workbook data (see Appendix M) identified the percentage of students meeting college readiness and the percentage of teachers covering at least 28 out of 47 standards. As stated previously, the binomial test for ACT scores demonstrated 63% of the students are not proficient in at least 60% of the science material on the ACT, $p = .00$. Conversely, the binomial test for ACT workbook standards showed 53% of the teachers cover at least 60% of the science ACT standards; this test was not significant because the observed proportion was too close to the 50% test proportion (a suggestion for future studies would be to increase the test proportion to 75%). While both groups did not yield significance, the results suggest that students are not testing above the amount ACT science standards applied in science classrooms at QRS High School.

The archival ACT data confirmed the average performance of students at QRS High School is below college readiness standards, while the ACT workbook data provides an explanation for the scores. Refer to data detailing the percentage for individual course data (see Appendix M) to recall the science teachers at QRS High School cover more than 85% of the standards for ACT scores from 13-23. However, the percentage drops to less than 45% coverage for scores ranging from 24-36. One-sample *t* tests and binomial tests data revealed roughly 63% of students did not meet the science college readiness standard. These numbers indicate a significant relationship between the number of standards teachers include in their curriculums and student science ACT scores.

Comparison of archival ACT data and ISIS scores (research question 2). Research Question 2, what is the variation in the proportions of past student ACT scores and scientific inquiry concepts the science teachers at QRS High School are exposing their students to in the classroom, was examined through *t* tests and binomial tests. The binomial tests (see Appendix M) identified the percentage of students meeting college readiness and the percentage of teachers using inquiry *sometimes to often*, 3 out of 5. The binomial test for ACT scores demonstrated 63% of the students are not proficient in at least 60% of the science material on the ACT, $p = .00$, while the binomial test for ISIS scores shows that 89% of the teacher population includes at least 60% of the inquiry items on the ISIS, $p = .04$. Each group yielded significance suggesting that students are not testing above the amount of inquiry applied in science classrooms at QRS High School, which is a desirable outcome. Recall that the ACT measures scientific inquiry concepts (ACT, 2013b). However, *sometimes to often* on the ISIS scale equates to anywhere from the low end of a 3, 30%, to the high end of a 4, 74% on the 5-point scale. This varying degree of inquiry usage may help to explain science ACT scores that are not meeting the college readiness standard.

Even with this comparison data, it was difficult to visually equate the ACT and ISIS data. The QRS school district required the ability for stakeholders to *see* some form of parallel data (M. Hunter, personal communication, April 10, 2014) between the two data sets. Therefore, to provide a visual representation of the comparison between archival ACT data and ISIS data for the district, I configured ACT scores to a 1-5 scale, thereby resembling ISIS data. It must be noted that this scale was specifically created for its intended use at QRS school district. In the converted ACT scale, 0-19=1, 20-23=2, 24-27=3, 28-32=4, 33-36=5. The visual representation of this data (see Appendix M) illustrated that more than 70% of the students score either a 1 or a 2 on the converted ACT scale for science and the composite score, which equates to an ACT score between 0 and 23. Conversely, the average teacher score on the ISIS was a 3.6. Data Table 8 displays the mean scores of the average teacher ISIS score, 3.6, the adapted average ACT science score, 2.06, and the adapted average ACT composite score, 2.02.

Table 8

Descriptive Statistics for equated ISIS Data

	Minimum	Maximum	Mean	Std. Deviation	Variance
ISISAVG	3.60	3.60	3.6000	.00000	.000
ACTSCI	1.00	5.00	2.0640	.88202	.778
ACTCOMP	1.00	4.00	2.0171	.91271	.833

Note. N = 469 for ACTSCI and ACTCOMP. The ISISAVG is only the overall ISIS average score, not multiple scores.

The analysis revealed a difference between the teacher average and both science scores, 1.54, and composite scores, 1.58. These differences signify up to a 7-point gap between the presumed level of inquiry and the actual ACT scores. Further analysis, including a one-sample *t* test evaluated the mean of a test variable, ISIS equated science ACT scores, for a significant difference from the constant, 3.0 (or a score of 66 out of 110 for individuals) on the ISIS scale (IBM, 2012). The output data can be found in Appendix M. The sample mean of 2.06 (*SD* = .88) was significantly different from 3.0, *t*(468) = -1176, *p* = .00. The 95% confidence interval mean for ISIS equated science ACT scores ranged from -48.02 to -47.86. This indicates the average student science ACT score at QRS High School is significantly below the average amount of inquiry methods covered by teachers on the ISIS, 3.6. Thus, there is room for improvement. The binomial test for ISIS equated science ACT scores (see Appendix M) identified over 70% of the students taking the science ACT at QRS High School are not skilled in at least 60% of the inquiry items on the ISIS.

Phase 2: Interpretation of Qualitative Findings

The nine qualitative interview questions (see Appendix K) enhanced the results of the Phase 1 data by providing insight in to why the proportions of ACT scores, 63%, ACT workbook data, 53%, and the ISIS, 89%, are inconsistent. When, as discussed in Research Question 1, only 53% of teachers are covering 60% of the 47 ACT standards and 63% of students do not score well enough on the ACT to be college ready, the science department needs an answer to the question *why*. Additionally, as examined in Research Question 2, 89% of the teachers in the science department cover at least 60% of the inquiry concepts listed but 63% of the students are not considered college ready. Establishing a resolution process for the research questions happens through *understanding*, which occurs from the interview questions.

Interview Questions 1 through 4 and their corresponding themes support both quantitative research questions. Active student learning, application of skills, and student application (themes for Questions 1, 2, and 4) cannot occur unless teachers can structure a lesson that appears unstructured (theme for Question 3). The science teachers at QRS High School agree that inquiry helps students learn science more effectively (Question 2). However, the science teachers have differing viewpoints on what inquiry actually is (Question1) and what teachers and students need to know to conduct inquiry (Questions 3 and 4). Deviations within the department can help to understand why there is variation in the proportions of the Phase 1 data; for example, Respondent 6 stated, “Students use prior knowledge to actively engage in new problem solving skills where they come up with their own answers. Open-ended inquiry is teacher facilitated, not led,” and Respondent 7 said, “Open-ended has no one answer. As long as the answer relates to the question and is justified or supportive by the information it should receive partial to all credit”. Discrepancies such as these, though slight, can have an effect on what inquiry techniques and ACT standards are covered in science classrooms, consequently affecting the proportions.

Interview Questions 5 through 9 and their corresponding themes provide reasoning as to *why* there is a discrepancy in the proportions discussed in the quantitative analysis. Teachers need time (theme for Question 5) to implement open-ended inquiry lessons (Question 5) and monetary assistance (theme for Question 6), noted as the largest problem within the science department (Question 6), to acquire some of the equipment needed for inquiry units. Respondent 8 noted that a “lack of funding and support for growth” are a constant external hindrance to the department (theme for Question 7). The question then becomes how to solve these issues (Question 8) so the department might avoid the same outcome (Question 9). The resolution can be found both outside the department: "Principals and Superintendents need to listen to the needs of the teachers and actually follow through" (Respondent 6) and within the department, "Offer cross-curricular activities between English, Math, and Science" (Respondent 8) to gain back some of the lost time. The science department at QRS High has an opportunity to learn from its own comments so the department can increase the proportion of inquiry techniques and ACT standards applied in the classroom, thereby raising the proportion of students prepared for college science.

The collective theme for the nine interview questions was time. See Appendix O for a narrative of the central theme. Teachers need time to apply the following participant-suggested action agendas: (a) attend workshops where the focus is on scientific inquiry and learning how to enhance inquiry techniques in the classroom, (b) meet with other science teachers within the department to produce inquiry units, and (c) apply inquiry units in the curriculum. However, time is finite and, as Respondent 8 stated, "more emphasis is put into math and English. Science and social studies are secondary in growth." Limited time appears to emerge as the source of hindrance in the science department at QRS High School, thus delaying any correction of discrepancies within the department such as those revealed from the quantitative analysis. Therefore, my suggested application, or call for action (Yin, 2011), for these agendas is on professional development days during the school year, the week after school is released for the summer, and the week before school is back in session. However, the school district would most likely have to pay for the extra two weeks as those are not considered part of the contracted days for the district. This strategy would reduce the number of days teachers are out of their classrooms, thus increasing the number of days in which teachers could apply inquiry units in the curriculum. Increasing the number of inquiry units and concepts would increase the proportion of inquiry and ACT concepts covered in classrooms at QRS High School.

Summary of Findings

An explanatory mixed methods program evaluation allowed me to collect quantitative *and* qualitative data. As such, I was able to provide both answers and understanding for the research questions (Creswell, 2008, 2009; Lodico et al., 2006, 2010). Research Question 1 involved the variation in the proportions of past student ACT scores and ACT science college readiness standards, while Research Question 2 entailed the variation in the proportions of past student ACT scores and scientific inquiry concepts. Fundamentally, Phase 1 data confirmed average student ACT scores below the college readiness standard. The data indicated teachers employ a slightly above average amount of inquiry and science ACT standards in the classroom but were inconsistent with which standards were covered in courses taught by multiple teachers. Phase 2 data revealed teachers feel open-ended inquiry is useful in the science classroom but need time to become skilled, collaborate and prepare, and implement it in the classroom so they can raise the proportions confirmed in the Phase 1 data.

The research questions and data from the program evaluation for this study helped to make recommendations for the teachers at QRS High School (full evaluation report can be found in Appendix A). While data established that students are not testing above the amount of inquiry and ACT standards applied in the classroom, I would like to see the science teachers in QRS High School increase the amount of inquiry and ACT standards from 60% to 75%, potentially resulting in average science ACT scores that increase to college readiness levels. In the evaluation report for this study, I suggested an actual transformation of the science curriculum in an effort to increase science ACT scores, close achievement gaps, and create social change on the local level. This implies increased ACT scores will provide positive social change for not only the students, but their school and community as well. The sole purpose of research cannot be about the scientific inquiry (Ali et al., 2011). Essentially, this statement demonstrates that during the evaluation process, teachers must think about the people involved. As suggested in the report, a transformed science curriculum will require the efforts of the entire department with consideration for the students, factors affecting them as individuals, and the way the students learn.

Substantiated by the literature review and mixed methods data analysis, I recommend the one rural science department work as a cohesive unit to focus on instructional needs, identify instructional goals, and compare curriculum content and expectations (ACT, 2006) to produce the following tentative inclusions for the science curriculum: (a) covering more Next Generation of Science Standards (NGSS) and ACT standards, (b) using more of the ISIS inquiry techniques, (c) incorporating more hands-on activities, (d) conducting more cross-curricular tasks, and using (e) collaboration time and (f) research based models as techniques (in Section 3, I elaborate on such models) to implement these inclusions.

Conclusion

In a program evaluation, the goal is to improve the program as quickly as possible. In this project study, the goal was to implement changes to the curriculum to improve science skills in QRS High School in a reasonable amount of time. The idea behind a needs assessment is to determine deficient areas to improve the program. For this study it was important to determine past student performance on the ACT, the degree to which teachers employ inquiry based instruction, the number of ACT skills assessed in each course, and individual teacher views concerning inquiry and skills. Consequently, the Phase 1 data gathered was statistical data and analyzed in SPSS and the Phase 2 interviews provided themes so I could make recommendations to the high school science department concerning a revised science curriculum.

The recommendations to the high school science teachers came from the problem, research questions, and collected data from this project study. The problem was the achievement gap of scientific achievement among QRS High School, the state, and national scores. The quantitative questions pertained to the relationship of past ACT scores to ACT college readiness standards and science inquiry usage. The qualitative question explored teachers' viewpoints of their impact on science instruction. Originating from this information, one can only expect that teachers have an effect on the curriculum delivered. Therefore, if teachers have overlooked the acquisition of particular science skills, their curriculum would not include activities containing those skills.

In Section 3, I discuss the actual project, which is an evaluation report for the mixed methods program evaluation; review literature concerning program evaluations;

discuss research-based ways to implement the recommendations of this study, based off the data analysis; and provide a timeline for implementing these changes. In Section 4, I reflect on the project and draws conclusions.

Section 3: The Project

Introduction

In Section 3 of this project study, I depict a comprehensive overview of the actual project, which is an evaluation report for the mixed methods program evaluation of the science department's curriculum in terms of inquiry usage and ACT standards applied in classrooms at QRS High School. Goals of the project stemmed from the results of collected data. The summative measures indicated that in the past, teachers included a standard amount of inquiry and ACT standards in the classroom but would need more time to develop and implement inquiry units. Additionally, this section provides a rationale for choosing a program evaluation, a review of the literature on research based models to help implement various scientific inquiry inclusions, a proposal for implementation of suggested modifications, an evaluation of the project itself, and implications for social change.

Description and Goals

The influence behind this project study was low performance on college readiness assessments, such as the ACT, at QRS High School. The purpose of the program evaluation was to assess the effectiveness of the science curriculum in QRS High School. The prospective goal from this study is to change the way teachers deliver information to students so those same students obtain needed science skills and enhance their performance on assessments.

I designed the inquiry and ACT curriculum evaluation at QRS High School to provide a summative report entailing strengths and weaknesses of the department through the relationship of ACT scores and inquiry usage or ACT standards applied in classrooms. Generating these relationships involved the following summative evaluation design: (a) providing background data to substantiate the proposed achievement gap on the science portion of the ACT, (b) giving each of the nine science teachers quantitative instruments including the ISIS survey and the ACT science college readiness standards workbook survey and, qualitative interviews to establish an understanding of the quantitative data, (c) analyzing the collected data, and (e) recommending changes for future practice. This design was appropriate stemming from the need to produce summative baseline data of past practices in the science department at QRS High School to determine effectiveness of the program. Specifically, the program evaluation was looking for the inclusion of ACT-related material. The intent of the actions listed was to provide baseline statistics so the department can modify deficient areas to help future students acquire scientific skills at QRS High School. This program evaluation critically reviewed practices at the high school and identified an existing achievement gap; collected and analyzed necessary data, which determined a need to increase the amount of inquiry and ACT skills taught to help increase scores; and provided the basis for an evaluation report to propose a course of action. The overall goal of this study was to improve student scientific inquiry skills quickly. Maintaining the goal to improve scores and the understanding that students retain more of the given information in an inquiry based class (Blanchard et al., 2010), the suggested course of action is to increase QRS High School's scientific inquiry based curriculum.

Rationale

Background science ACT data emphasized the necessity for a program evaluation. Assessing the current curriculum in the science department was the best method to determine needed modifications, if any, to help increase the acquisition of science skills. The rationale for evaluating the current program includes the following: evaluations are less invasive (Creswell, 2009) as they do not require unnecessary time away from students, I wanted to assess what teachers are covering verses how students are testing, I wanted the ability to create change in a timely manner (Lodico et al., 2010), and evaluations can evolve in conjunction with the program. Additionally, a program evaluation is a suitable method to create written objectives and provide specific benchmarks (Lodico et al., 2006, 2010; Spaulding, 2008). The goals of this evaluation paralleled QRS High School's mission to "provide exemplary and lifelong learning opportunities today, in preparation for tomorrow." As such, this project serves as a pathway to create positive social change for the current achievement gap in QRS High School by providing necessary recommendations to create this change.

The baseline data from this evaluation was useful for helping the science department make changes and move forward. The collection and analysis of summative data during the evaluation could help to address the actual effectiveness of the curriculum. The use of *t*-tests and binomial tests of ACT student data, ISIS data, and ACT workbook data provided relationships of the proportions between data sets and revealed an inconsistency of inquiry and standard usage within the department. Teachers cannot expect students to test well if teachers who teach the same course are not consistent with inquiry and ACT standard usage. Interviews provided understanding for the quantitative data. Teachers need more time to collaborate, which could assist with inconsistencies and aid in the application of my inquiry units. Future formative data analyses could evaluate the effectiveness of any changes, allowing for additional modifications.

Review of the Literature

I conducted a secondary literature review as a tool to support the use of a program evaluation for this study. For the analytical assessment of program evaluations, I reviewed various sources on types of program evaluations, research-based recommendations for program evaluations, and the use of results from program evaluations. Additionally, I researched recommendations made in the Section 2 findings as a method to support the implementation of these proposed changes.

The organization of this literature review includes (a) how a program evaluation was appropriate to help increase science skills for students and (b) the analysis of using the recommendations from Section 2 both inside and outside the classroom to increase science skills and performance.

I conducted an exhaustive search for resources through multiple databases including EbscoHost, ERIC, Google Scholar, the local library, Proquest, and the Walden University online library. The compiling of studies occurred through search parameters including Boolean operators and key terms such as the following: program evaluation and needs assessment (Mertens & Wilson, 2012; Patel, 2010; Royse et al., 2009). Secondary search terms included the following: scientific inquiry techniques and models, specifically the BSCS 5E instructional model (Bybee et al., 2006; Creghan & Creghan, 2013; NSTA, n.d.); hands-on learning (Brookfield, 2010; Johnson, Zhang, & Kahle,2012; The National Research Council, 2000a, 2000b, 2005, 2012; Sungur & Güngören, 2009); cross-curricular teaching (Guzzetti & Bang, 2011; Kellaghan, Greaney, & Murry 2009; McKinney & Taylor, 2012; Pearson et al., 2010); higher-order thinking (Bybee, 2013; Capraro, Capraro, & Morgan, 2013); and professional learning communities and professional development (Capraro et al, 2013; Defour, Defour, & Eaker, 2009; Koba et al., 2013; Lindsey, Jungwirth, Pahl, & Lindsey, 2009). Sources for this literature review came from books, professional journals, referred journals from reference lists, and research dissertations.

Types of Program Evaluation

Program evaluations are suitable for education as evaluations have the ability to adapt to a school's needs. As noted by Patel (2010), education is dynamic. Though evaluations have two commonly used classifications, goal-based and objective-based, they can be itemized further by purpose and type. Mertens and Wilson (2012) identified at least 27 different types of evaluations dependent on the purpose. For example, as with this study, I used an objectives-based needs assessment to gain insight into the current curriculum so the department could identify inhibitors and facilitators presently in place. Program evaluations help school districts determine the worth of a program through the following: placing the needs of students in the forefront, assessing curriculum(s), and placing an emphasize learning (Lodico et al., 2010; Mertens and Wilson, 2012; Patel, 2010). Each of these can provide a district with insight to determine strengths and weaknesses within a particular program.

By design, program evaluations can vary to meet the needs of the evaluator. However, any program evaluation is limited by time, resources, and has assets as well as limitations (Patel, 2010). The evaluator choses the type of program evaluation by such items as what the person would like to evaluate; what the purpose of the evaluation is; what the research questions are; when the evaluation is taking place, summative verses formative; and who the stakeholders are, which may change with the evolution of the evaluation (Lodico et al., 2010; Mertens and Wilson, 2012). As discussed by Lodico et al. (2010), most evaluators utilize an objective-based evaluation as it typically employs quantifiable objectives and benchmarks that participants should reach. Writing objectives first can influence the choice of data collection instrumentation and whether to collect formative or summative data. Patel (2010) provided a plausible answer as to why evaluate in the educational spectrum: educational program evaluations attempt to provide a systematic approach to issues most districts experience.

Research-Based Recommendations for Program Evaluators

Program evaluation is complex and diverse and provides a localized viewpoint of a concrete issue that is substantial to the evaluator (Mertens and Wilson, 2012). This evaluation followed the process of Royse et al. (2009) for conducting a needs assessment, which was categorized into three phases: pre-assessment, assessment, and post-assessment. This format helps to define the local issue and demographics, establish why the evaluation is necessary, and organize the data collection process and analysis of the data. Furthermore, the evaluator should comprehend the motivation behind the assessment, the purpose and potential impact, available resources, time involved, and ethical considerations if dealing with participants (Royse et al. 2009). The items listed help determine the appropriate methodology, which can be quantitative, qualitative, or mixed methods. As discussed by Creswell (2008, 2009) and Lodico et al. (2010), each methodology has an appropriate use. Quantitative research is based on statistical data, whereas qualitative research is based on an effort to understand *why*. Mixed methods research involves both quantitative and qualitative data to provide a comprehensive representation of statistics and understanding of the issue (Campbell, Gregory, Patterson, & Bybee, 2012; Fetters et al., 2013). Once the evaluation design and methodology are established, the researcher can collect data. Creswell (2008, 2009) and Lodico et al. (2010) discussed the use of standardized instrumentation to collect data, whether the data is quantitative or qualitative, such as surveys, archival records, interviews, and observations. The analysis of such data should reflect the research questions while identifying potential patterns (Royse et al., 2009). The data analysis produces the findings of the evaluation: is the program effective. These findings constitute the evaluation report presented to directly to stakeholders (Lodico et al., 2010). Even with the complex nature of a program evaluation, utilizing an evaluation plan, such as the one discussed earlier, clearly defines the intended course of action and helps keep the evaluator focused so modifications can be made to a program in a reasonable amount of time.

Using the Results of Program Evaluation

Educational program evaluation has evolved since its inception. Today, evaluations challenge districts and evaluators to measure comprehensive programs to produce action, instead of evaluating distinct and separate entities (Patel, 2010). At the conclusion of the evaluation, the evaluator presents the evaluation report to stakeholders who have the opportunity to use the finding in order to create change or produce policy (Royse et al., 2009). It is important to think of such items as how the results will be communicated, to whom the evaluator is communicating, and how to use the findings (Mertens and Wilson, 2012). Multiple researchers (i.e. Mertens & Wilson, 2012; Patel, 2010; Royse et al., 2009) discussed these strategies to apply when writing the evaluation report and presenting findings to increase the probability of use by stakeholders: (a) remember the audience, for it may be more appropriate to communicate in a less formal style; (b) be concise by presenting only what is needed such as an introduction, the methodology, the findings, and limitations; (c) if an executive summary is typed, the report should be short and only highlight important details, three to four pages on average; and (d) pay attention to details by researching other presentations, knowing how much time is allocated, knowing when questions should be asked, and making sure the audience can read and understand the presentation. The idea here is to ensure the audience members leave the presentation motivated to modify practices (Mertens and Wilson, 2012) so they are more likely to generate change.

The intended uses of a program evaluation to generate change can take multiple forms. Mertens and Wilson (2012) discussed five intended uses of evaluation findings, though some uses do not create change. *Instrumental use* has a direct impact on decision-making. *Conceptual use* effects how stakeholders think. *Symbolic use* occurs when the evaluation is more of a façade and policy makers have no intentions on applying the findings. *Persuasive use* provides validation for previous perceptions. *Legitimate utilization* is similar to persuasive use but provides validation for previous findings from another evaluation. The five uses presented demonstrate that the application of program evaluation findings should meet the needs of those directly affected by the findings and the associated recommendations.

Analysis of Theory and Research

Examining the science curriculum at QRS High School to look for inquiry based instruction was one step in recognizing the role students have in their education. Giving the students inquiry based coursework, coupled with cross-curricular work, allows them to engage in critical thinking and obtain the needed skills for future science careers (Dolan & Grady, 2010; Grady, 2010). The same inquiry based coursework is important for standardized assessments ranging from state to international levels, such as the state End of Course (EOC) exam, the ACT, and the PISA international test. Additionally, due to multiple levels of testing, every science teacher must understand the comparisons made for each of these tests and the subsequent results (Bybee, 2007, 2011, 2013; Furgol et al., 2011). Teachers can implement changes inside and outside the classroom based on the needs of their students.

Within the classroom. Overlooking the value of individual intelligence and critical thinking skills is, unfortunately, a familiar situation in the educational system.

This program evaluation included suggested modifications to aid in rectifying this situation. As such, implementing the suggested changes within science classrooms at QRS High School could help improve student acquisition of science skills. In particular, Gopalsingh (2010) provided a thorough argument for the underachievement of science students including the following reasons: science students must have a higher cognitive skill base than math and English, science is not an AYP tested area, and teachers do not typically place science literacy in other core subjects (p. 120). Based on results from data analysis and findings from section 2, this study suggests the inclusion of the following: inquiry techniques, cross-curricular and hands-on activities, and the use of more higher-order thinking through the application of NGSS and ACT standards. Sulaiman, Hassan, and Yi (2011) found high school teachers lean toward the use of interactive teaching styles which help older students learn efficiently; the student-student and teacher-student interactions in high school could help broaden the use of the recommended inclusions while still helping to prepare individual science students for post high school life.

BSCS 5E instructional model. The 5E instructional model is a student-centered inquiry model appropriate for use in science classrooms at QRS High School. The model is based on constructivism and, by name, focuses on 5 *E* phases for learning science: *engagement, exploration, explanation, elaboration,* and *evaluation* (Bybee et al., 2006; Creghan & Creghan, 2013; NSTA, n.d.); in essence, constructivist models provide students with a platform to alter previous perceptions (NSTA, n.d.). Namely, Bybee et al. (2006), Creghan and Creghan (2013), and NSTA (n.d.) discussed these five phases. During phase one, engagement, the teacher initiates the learning task. The task should bridge past and present learning while focusing student learning on the objective, or learning outcome. Phase two, exploration, entails cooperative activities during which students initiate their own creativity within the confines of the current concepts. Phase three, explanation, allows the teacher to formally introduce the topic and students to articulate their findings from the first two segments. During the elaboration phase, phase four, teachers challenge students so they can correct any lingering misconceptions and deepen their understanding to make generalizations about the skill or concept. The fifth and final phase, evaluation, provides students the opportunity to evaluate themselves while the teacher is also evaluating the student. The evaluation can be formal or informal. Additionally, Eisenkraft (2003) proposed the expansion of the 5E model, appropriate at the high school level, to also include *elicit* and *extend*. To elicit prior knowledge, teachers ask students to catalog what they already know about a topic (Eisenkraft, 2003; Miranda & Hermann, 2012). When teachers *extend* a student's knowledge, they are ensuring students can apply their newly learned skill or concept by practicing the reassignment of learning to new conditions (Eisenkraft, 2003). The 5E/7E instructional model can provide the science teachers at QRS High School with a cohesive, hands-on, approach to inquiry learning.

Hands-on learning. Ways in which a science teacher can create a student centered, inquiry classroom include the emphasis of tasks that motivate students, autonomy support, and individual student effort (Sungur & Güngören, 2009). Specific examples in science classrooms include "field works, projects, laboratory experiments and simulations…brainstorming, group working, problem-solving, and cooperative learning" (Sungur & Güngören, 2009, p. 895). Johnson, Zhang, and Kahle (2012) conducted a study utilizing some of the examples previously listed and found classrooms involving hands-on inquiry learning outperformed those involving less effective teaching strategies. The retention of information in an inquiry based classroom through hands-on instruction techniques, which also helps with the cognitive and literacy skills discussed by researchers (i.e., Brookfield, 2010; and The National Research Council, 2000a, 2000b, 2005, 2012), would encourage students to become successful academic learners and to take an active role in their own education.

Cross-curricular. Curriculum integration, both horizontal and cross-curricular, would help with the cognitive skill base and the literacy skills needed, though each subject must show relevance for it to work (McKinney & Taylor, 2012; Pearson et al., 2010). For example, the acquisition of skills, such as scientific speech, cannot be limited to individual courses. Schools must expect interdisciplinary instruction, such as literacy-based science instruction, to obtain all necessary skills so students may increase their academic output (Guzzetti & Bang, 2011; McKinney & Taylor, 2012). Students may learn skills in English and math, but they can enhance these skills in other subjects. Similarly, Kellaghan, Greaney, and Murry (2009) emphasized the language in an assessment is essential and teachers cannot expect a student to do well on the assessment if the literacy level is beyond that particular student's abilities, authentic literacy (Schmoker 2006, 2007a). Furthermore, while standardized tests do rely heavily on literacy skills (Visone, 2010), English teachers must also realize the importance of other necessary skills, like scientific inquiry, so they may reciprocate in the preparation of students; for example, English teachers can assist in what Capraro, Capraro, and Morgan (2013) called constructing a common language. According to McKinney and Taylor (2012), cross-curricular integration can improve teacher-teacher and student-student interaction while building relationships, aiding with curriculum and program reviews, and even providing interactive competitive opportunities at the national, or even international, level. When teachers from multiple disciplines are teaching students to use scientific skills, such as inquiry, students' attitudes toward science improves (Guzzetti & Bang, 2011), and it can also improve their understanding of the actual scientific process.

NGSS and ACT standards. Students throughout the United States take the ACT, which has been widely accepted for more than 50 years, to provide plausible and unbiased standards to demonstrate preparation for college, thus exhibiting a student has learned the skills needed for college (ACT, 2010b, 2011c, 2011d). The scientific concepts addressed during the ACT include topics covered under NGSS and higher-order thinking skills, such as those previously discussed (ACT, 2013b). A study conducted by Furgol et al. (2011) supported the validity of ACT scores and established the scores are reliable to predict college readiness, college enrollment status, academic proficiency, and first-year college success. Based on the data analysis from Section 2, less than 40% of students at QRS High School meet college readiness standards in science. As stated earlier, students need a 23 benchmark score in science to be considered prepared for college (ACT, 2013b). This achievement level implies students need a higher-cognitive skills base in science.

Effective critical thinking skills allow students to demonstrate the overt nature of their learning styles while demonstrating success in mastering an objective. Participatory learning involves active engagement (Lemke & Coughlin, 2009). The NGSS and ACT standards provide teachers with concepts and practices to build lessons within the classroom (Bybee, 2013). This approach translates to teachers providing students with the information to accomplish their goals, but the student must integrate this information and apply it. For example, Capraro, Capraro, and Morgan (2013) specifically discussed STEM project-based learning, which could fully incorporate the higher-order inquiry techniques of the NGSS ACT standards within science.

Outside the classroom. Professional learning communities and professional development opportunities outside of the classroom can aid revitalization within the classroom. Multiple researchers (i.e. Capraro et al, 2013; Defour et al., 2009; Koba et al., 2013; Lindsey et al., 2009) determined PLCs can be successful when there is a catalyst to support change, when the group has both a clear and shared vision where the main focus is student learning, and the willingness to adapt and share practices. As stated by Capraro et al. (2013) when discussing how a PLC, or even a small learning community (SLC), can support STEM learning, a PLC facilitates development within a school system. Koba et al. (2013) discussed professional development opportunities in science through which learning how to teach target inquiry in such classes as chemistry can help a student's scientific literacy and, therefore, achievement. A PLC or SLC could help the science department confront some of the discrepancies revealed during the data analysis in Section 2.

Implementation

Potential Resources and Existing Supports

This needs assessment of the existing science curriculum required multiple levels of data collections due to its mixed methods design. To conduct the summative evaluation of past practices, I needed both surveys and interviews to generate baseline data for the program evaluation objectives (see Table 2). Coupling student ACT scores (see Appendix F) with teacher inquiry usage (see Appendix H and I) and ACT standard usage (see Appendix D and E) provided the district with quantitative instruments to use for future formative assessments to verify achievement of previous listed benchmarks. In addition to quantitative instruments, the teachers completed an interview (see Appendix K and Appendix L) in an attempt to understand the quantitative data. These four evaluation tools produced baseline data for the high school and district, thus providing all significant stakeholders an assessment of strengths and limitations in the current science curriculum.

Possible future data collections could evaluate the success of benchmarks and could be formative, or ongoing, to support making changes to the program as needed. The objectives and benchmarks from the objectives-based program evaluation could help guide the science department when deciding what adjustments to make in the science curriculum. To conduct any future formative assessments, once changes are in place, I would need the following resources: full access to student ACT scores through the school's database, teacher cooperation when asking all teachers to complete ISIS and ACT workbook surveys periodically, and the support of principals and superintendent to conduct any future assessments. This future data could be broken down into statistical data such as socioeconomic factors, gender, free and reduced lunch, special education, or even by students who transferred to the district.

Potential Barriers

A sequential explanatory mixed methods needs assessment of the science program was quite extensive. By definition, I had a specific sequence to follow while conducting this evaluation. I could not move to the next component until I collected all Phase 1 data. I then had to analyze Phase 1 data before proceeding to Phase 2 data. The school district had 12 snow days, presenting constant interference during data collection. Teachers had issues getting to the school to examine curriculum components.

An additional barrier of the evaluation occurred during the initial Phase 1 data analysis. I had planned to complete Pearson *r* correlations between ACT and ISIS data, and between ACT and ACT workbook data. However, there were not the same number of cases in any of the data sets, and individual ACT scores were not matched up to individual teachers (to maintain anonymity), rendering any analysis impractical. I spent almost 4 weeks attempting to run the analysis and then researching to find a new data analysis approach that was compatible to the study, resulting in delays for Phase 2 data collection. Additionally, during the final stages of the study, I attempted to strengthen the Phase 1 data analysis through ANOVA or ANCOVA data analyses. However, these analyses would not work because the independent variable, ISIS scores or ACT concepts, and dependent variable, ACT scores, did not have the same number of cases.

Proposal for Implementation and Timetable

Conducting an evaluation of science practices at QRS High School involves two phases: conducting a summative evaluation so the department can produce modifications to the curriculum and then ongoing formative evaluations to inspect benchmark checkpoints. The multiple stage implementation permits the science department, coupled with stakeholders, to determine vulnerable areas and address those areas in terms of the amount or type of inquiry or, which ACT standards teachers should cover in each of the 11 science courses. The initiation of future formative collections would be during the school year, at least one semester after changes are in place and students have had an opportunity to take the ACT test.

The successive, multiple-phase design provides the district with the opportunity to continue with annual or bi-annual evaluations to identify areas for possible improvement. The use of both quantitative and qualitative instruments permits the district to use just statistical data or to add teacher perspective. District stakeholders may indicate they would prefer to collect data only annually or even bi-annually. A longer duration between evaluations would provide teachers with needed time to alter, plan, and implement changes within their curriculum(s). Data collections over a longer time would also generate sufficient data to track the percentage of students who successfully reach the ACT science readiness benchmark relative to modifications made in the curriculum each year.

For this study, I conducted the summative evaluation of past practices because the high school did not have any baseline data to determine successful changes made in the science curriculum. My proposed timeline to *fully* implement all desired changes includes roughly one summer plus one full school year or, if teachers cannot meet during the summer, one demanding year. I estimate 3 months to identify instructional goals, and compare curriculum content and expectations; 2 months to decide which ACT standards and ISIS inquiry techniques should be covered in physical science and biology (these two courses make up a student's first two years of science); 1 addition month for the other 9 courses; and 2-3 months for cross-curricular tasks. Any collaboration time would be concurrent with the 9 months listed above.

Roles and Responsibilities of Those involved

Due to the complex nature of this study, I had to perform a dual role. Not only did I engineer the mixed methods program evaluation, I had to participate in the study. As the engineer, I had to design the program evaluation for QRS High School. I was responsible for choosing appropriate quantitative and qualitative instruments, gaining permission from copyright holders and the district, holding a meeting for potential participants, coordinating and obtaining both survey and interview data, analyzing quantitative data, and analyzing qualitative data. As the sole analyzer, I was responsible for selecting suitable tests to run statistical data for quantitative data, coding and producing themes for qualitative data, and producing recommendations to the high school. There were no outside personnel involved as the qualitative interview was electronic, thereby eliminating the need for participants to review findings.

Project Evaluation

This project study utilized a set of evaluation tools to examine the current science curriculum. The findings and recommendations from this evaluation are limited for use in QRS High School. Due to the nature of the instruments employed, the school district could continue with semester, yearly, or even bi-yearly evaluations to determine future student needs as a result of modifications to the science curriculum. The ISIS and ACT workbook data would be fundamental resources for any future evaluations. The suggested schedule for future data collections would allow for both formative and summative data collections to assess student and curriculum needs through the identification of inadequate areas in the science program. Interview data could help the district understand findings. Continued reviews of the science program could help stakeholders maintain a higher level of confidence in the program.

Implications Including Social Change

Local Community

When a school is pivotal to the success of a local community, the relationship between the community and the educational system becomes essential to the educational success of a student. This relationship becomes even more important in a rural setting where there are unique challenges to this type of location (Vernon-Feagans et al., 2010; Hardré, Sullivan, & Roberts, 2008a, 2008b). Rural teachers have an impact on their students, which Hardré et al. (2008b) indicated could be a result of the dual role rural teachers have as educators and vital community members. Students learn through their immediate environment. Coupled with other influences, the educational system (i.e., teachers) should help provide a support network for each student to aid in the student's success. This project study provided the statistical data to commence change within the science department to aid in future student success by exposing students to more inquiry and STEM initiatives, which helps students connect to their direct surroundings (Asunda, 2011; Baine, n.d.; Eberle, 2010). Brookfield (2010) and The National Research Council (2000a, 2000b, 2005, 2012) discussed making those important connections in the classroom and utilizing higher order thinking. The identification of strong and weak components within the science department addressed the use of inquiry based methods, which, in turn, help to make these connections easier for students. The significance here is to encourage students not only to achieve, but also to relate to their immediate environment and create social change by directly addressing the improvement of their school and community.

Far-Reaching

One step for the United States to advance in PISA standings is to secure more students in science courses, where teachers help students with scientific skills. From there, teachers have the responsibility to engage students and to pique their interests. Researchers have suggested such items as (a) creating a real-world curriculum, (b) having businesses help determine what students need to learn, (c) participating in more hands-on activities, (d) having guest speakers in STEM careers, (e) performing activities that use collaboration, (f) selecting problem-solving coursework, and (g) integrating more technology (Asunda, 2011; Baine, n.d.; Feller, 2011; Schiavelli, 2011). By accomplishing these tasks, QRS High School could create an educational environment such as the one discussed by President Obama in 2009 where educators increase the literacy rate in science to produce critical thinkers, the United States moves up in the PISA standings, and more students are exposed to STEM education (Asunda, 2011; Baine, n.d.; Eberle, 2010). Developing an inquiry curriculum with the components listed is one step toward producing critical thinkers, moving up in the testing ranks, and exposing more students to the science portion of a STEM education.

ACT, Inc. (2007, 2008, 2009a, 2009b, 2010a,) completed multiple studies providing substantial evidence that taking the ACT is an appropriate assessment to measure college readiness through the raw scores, benchmark standards, and the composite score. Thus, the use of the ACT in all 50 states as a high school exit exam would be a foundation for a national common assessment for which college readiness benchmarks could be the normal paradigm to assist students in their transition to college. The use of the ACT as a national test could assist in streamlining NAEP. The use of college readiness benchmarks from the ACT would provide data from actual student performance (ACT, 2011g). Helping students at QRS High School acquire the necessary skills now for future coursework, such as college science, could help students take a nationally mandated test with a successful outcome.

There is also a call for Common Core Standards on the international level in all core classes. Professional organizations within the fields of English and math have initiated the process while science is working on the NGSS (Achieve, Inc., 2014). Students can use these standards as a way to prepare themselves to work in the competitive international workplace. College and career readiness standards, coupled with the Common Core Standards and NGSS, provide a start for the United States to be internationally competitive.

Conclusion

The science curriculum evaluation provided a mixed methods perspective to determine current needs within the department to aid student success: (a) quantitative measures to identify inconsistencies and (b) qualitative measures to understand why there are inconsistencies. Through the use of multiple data collections and analyses, I collected enough data during the evaluation to provide school stakeholders with these recommendations: transform the science curriculum through the use of research based models such as the 5E instructional model, cover more NGSS and ACT standards, use more ISIS inquiry techniques, incorporate more hands-on activities and cross-curricular tasks, and employ more collaboration time. The research discussed in this section supports these recommendations so school stakeholders can make changes to the program (instead of abandoning the program), document data, and even add additional programs for underachieving students.

The final section, Section 4, of this study reflects on the project, myself, and draws final conclusions. In terms of the study, reflections include the strengths of the project, ways to correct any limitations the project may have, the project development, and the impact on social change. In reference to myself, I must contemplate the different functions I have portrayed such as the following: a scholar, practitioner, and project developer. Section 4 will also indicate implications, applications, and possible future research before drawing final conclusions.

Section 4: Reflections and Conclusions

Introduction

The notion of this project study evolved from aspirations to correct a discrepancy in science skill attainment at QRS High School. The purpose of the program evaluation was to assess the effectiveness of the science curriculum so teachers could focus on the improvement of science skills. The design of the evaluation involved quantitative and qualitative data to provide the high school with both baseline statistical data and an understanding as to why the discrepancy might be occurring. This sequential explanatory mixed methods program evaluation revealed significant findings for the science department. However, the evaluation lacked any student evaluation tools to provide an alternative perspective into the inconsistency of science skill attainment. Teachers can employ the recommendations from this evaluation to guide changes in the science program starting with the 2014-2015 school year, with all changes in place by the 2015-2016 school year. The influence of designing, researching, and implementing a project study that could increase student achievement is challenging to describe, though the effects are life-altering.

Project Strengths

The target of this program evaluation was a continuing issue within the school: lack of science skill attainment, measured by the ACT college readiness benchmark. Despite modifications within the science department in the past, there was a lack of data providing evidence for the standards the department was covering and the inquiry techniques being applied to cover those standards. Furthermore, the school district has not provided adequate time for PLC, SLC, or department collaboration time. This study provided data demonstrating a need for more time to collaborate so teachers can correct inconsistencies. Thus, the overall strengths of this evaluation were the design of the needs assessment (see Section 2) and the utilization of a mixed methods methodology (see Section 2).

Integrating research on program evaluations and needs assessments (Altschuld & Kumar, 2010; Mertens & Wilson, 2012; NOAA, 2013; Patel, 2010; Royse et al., 2009) with research on mixed methods methodologies (Creswell, 2008, 2009; Ivankova et al., 2006; Lodico et al., 2006, 2010), I constructed this program evaluation around three distinct phases (see Figure 1) with clearly defined individual objectives (see Appendix D) and overall objectives (see Table 2) and benchmarks. Through its design, the program evaluation provided documented statistical data for ACT scores, ISIS inquiry usage, and ACT standard usage and explanatory data for teacher perspectives. The quantitative data produced were from descriptive statistics, one-sample t-tests, and binomial tests in which the proportions of the groups were tested. The qualitative data generated were from coding and producing themes from interview data in which teacher perspectives could be identified. Although the analysis of data was time consuming, due to the explanatory mixed-method methodology and the extent of data collected, the evaluation proved successful in that the data generated provided substantial support for the findings and recommendations. As discussed by Mertens and Wilson (2012), this multi-tiered examination permits essential school stakeholders to determine if this study is appropriate for instrumental use or for a different application.

Recommendations for Remediation of Limitations

Irrespective of the successful outcome of this evaluation in producing reference data for the science department, there were limitations. Three limitations include the amount of time involved, being a novice at data collection and analysis, and the design not including student input. Future adjustments for these disadvantages could help address the problem differently or even provide a different perspective to the problem.

Sequential explanatory mixed methods evaluations demand an extended amount of time as this method requires data to be collected in a particular order, with one set of data being analyzed before moving to the next set of data. Though this design allows a researcher to obtain a comprehensive representation of the problem, the task proved to be too much for one person to conduct all the data collections and analyses in a timely manner. In the future, I would recommend multiple researchers working collectively, thereby saving time while making improvements promptly to the program.

As a novice data collector and analyzer, I had to take extra time to research different forms of data collection and ways to analyze the data. During the initial analyses, I attempted to run a Pearson *r* correlation and later on ANOVA and ANCOVA. Due to my lack of expertise, I did not realize the data analyses were not feasible due to differing numbers of cases in each set and students not being matched to teachers. I then had to spend additional time researching other forms of data analysis that conformed to the data. For future research, I would work with statistical experts in data analysis or at least another researcher with more expertise than myself.

Although the design of this evaluation was comprehensive, it lacked the perspective of students to address the problem. Student perception of the cause, or reasoning, behind the absence of science skill attainment could provide an alternative way to address the problem. Various examples of student self-perception examined by Hardré et al., (2009) and Alkharusi (2010) included perceived ability, perceived assessment environment, future goals, and interest. Each of these alternative perceptions could have an impact on addressing the problem and any subsequent solutions for addressing the problem. If the school collected this form of data from each science student all four years of high school, there would be longitudinal data of student perception into the lack of science skills. Valuable information such as this could also give science teachers the ability to alter, not only what material they deliver, but how they deliver the information to students.

Scholarship

Throughout this project study, I became well versed on what it means for a piece of literature to be current and peer-reviewed. Education is constantly evolving so literature must stay current or will be obsolete within a few years. With NCLB, AYP, school report cards, and the need for increasing teacher quality, districts have become accountable for knowing current legislation and how to respond appropriately (Lodico et al., 2010). Examining current legislation and research influences schools to reflect on current practice and take action to improve those practices.

While conducting the literature review, expectations were high that current research would be plentiful. The ACT has existed for more than a half a century.

Research quickly divulged that studies were either outdated or did not examine science, demonstrating a lack of current, relevant research. It was difficult with the scholarship available to find conflicting positions. To obtain conflicting viewpoints, I had to research subtopics (see Section 1) of academic success and later, program evaluations. Nevertheless, the scholarly debate provided an extensive representation within the literature. For example, researchers such as Creswell (2008, 2009) and Lodico et al. (2006, 2010) mainly discuss objective-based and goal-based evaluations. Mertens and Wilson (2012), Patel (2010), and Royse et al. (2009) described the multiple forms evaluations can assume. Similarly, Mertens and Wilson (2012) and Royse et al. (2009) presented differing views on how and what to present in an evaluation report.

I also discovered the importance in using multiple resources and databases to obtain information. It would be impractical to obtain all information with access to only one resource. As such, the use of multiple resources like EbscoHost, ERIC, Google Scholar, the local library, Proquest, and the Walden University online library provided more than enough current, peer-reviewed literature. Navigating through each database was a skill that took time to refine. I made multiple discoveries while researching Boolean operators and key terms such as the need to be specific but not too specific. For example, the search for *correlation* AND research AND design* in the ERIC database provided more than 1000 hits whereas *multiple intelligence AND science AND high school* for the years 2010-2012 that were full text and peer reviewed only provided 6 hits. Access to electronic resources saved hundreds of hours researching and offered more information than necessary, but it took time to learn how to navigate.

Project Development and Evaluation

As stated earlier, undertaking a sequential explanatory mixed methods program evaluation is a daunting task, particularly for a novice researcher. Without conducting research on program evaluations and taking an online interactive session through Walden University, I would have minimal knowledge on how to develop and conduct an evaluation. Using various resources from multiple researchers on program evaluations (i.e. Creswell, 2008; Lodico et al., 2006, 2010; Spaulding, 2008) and needs assessments (i.e. Mertens & Wilson, 2012; NOAA, 2013; Patel, 2010; Royse et al., 2009) provided me with the knowledge to develop the focused evaluation plan (see Figure 1) in this study.

While in the design phase, it was critical to consider resource allocation. Being a novice evaluator, I attempted to maintain a realist perspective. My ambition initially overtook being rationale when I thought the program evaluation should involve every subject offered at the high school. Although that could be a long-term goal, it was inconceivable to conduct a program evaluation of that magnitude alone and within one school year. Additionally, the high school did not have all necessary resources in place to conduct an evaluation of that magnitude. After researching and discovering the needed elements and the amount of time involved, I narrowed my focus to one issue within one department.

With a narrowed focus and a general knowledge of program evaluation, the next phase involved determining methodology. As a scientist, I visualize in terms of cause and effect; therefore, the obvious choice was quantitative methodology. After researching different quantitative measurements, however, it appeared the potential study did not involve enough participants. It took almost 4 months to alter my mindset. Although frustrating, I determined the methodology would need to be mixed methods. The methodology was adjusted further to sequential explanatory mixed methods as the bulk of the data were quantitative. The months of hindrance stemmed from a minimal level of research knowledge on qualitative work coupled with my attempt to be persistent in only using quantitative data. Eventually, the practicality of using mixed methods where the researcher presents both statistical data and understanding succeeded.

Completion of mixed methods data collection and analyses established a respect for participants' rights and an appreciation for computer software. The National Institutes of Health (NIH) training helped me develop an understanding for the participant side of research. The use of an online survey company, Survey Monkey, helped maintain anonymity for all participants and negated the need to have the participants be identified. The electronic nature of the data allowed me to cut and paste data into SPSS for data analysis, meaning a smaller chance for incorrect data input. SPSS organized the data and generated reliable descriptive statistics, frequency statistics, one sample t-tests and binomial tests data analyses within seconds, this would have taken months by hand. In summary, the computer and data software utilized facilitated in maintaining participants' rights while saving time.

Leadership and Change

Accountability is increasing on all levels in education (local, state, and national) with initiatives such as NCLB and AYP and the push for more data from individual school districts. It is imperative for educational researchers to be proactive in their districts or campuses to provide internal accountability and feedback so the school(s) may respond appropriately (Howard, McLaughlin, & Knight, 2012). Producing change in school districts to meet these standards is complex; someone must take on the leadership role to initiate change, from planning and design to research, analysis, and implementation. A report from the NCEA and ACT (2011) discussed school leaders self-assessing their practices using a system-wide approach with 20 characteristics for higher performance as a reference. A few of the characteristics include leadership accomplishing the following: directing PreK-12 alignment of curriculum in a backward design, starting with grade 12; providing updated, detailed curriculum resources; developing internal leaders; structuring collaboration at all levels including classroom, school, and district level; and utilizing appropriate, curriculum- and instruction-related, professional development opportunities. The success of individual schools and districts is dependent on leadership taking in the initiative to create change within the system.

Analysis of Self as Scholar

During my studies at Walden University, I have sharpened my skills as a scholar. The coursework while earning my specialist degree and then continuing in my doctoral work has educated me in the ways of search engines, discussion boards, and the true representation of what *current and scholarly reviewed* journals contain. As a science major, I had worked with APA style throughout my undergraduate degree but never to this extent. I am conveying my skills as a research scholar to the students at QRS High School. In each class, I have already added a research section covering topics such as plagiarism, how to conduct a scholarly search, what *current* means, how to assess the accuracy in a website, and how to cite using APA (only the basics). My educational tenure at Walden University has afforded me the experience of practicing the enhancement of my research skills, so I may now accelerate these same skills within my high school students.

Analysis of Self as Practitioner

As a teacher, I am constantly designing lesson plans. Even with my everyday skills as a practitioner, I found it quite challenging to maintain a timeline through each stage of the evaluation. For instance, I only planned on 1.5 months to conduct the first literature review as I had never needed more than 2 weeks to conduct research. Being a fulltime practitioner with a family and extracurricular duties at school caused ongoing delays. Additional delays derived from becoming distracted by all the information I was inundated with while researching. However, I quickly learned to focus on my research questions and objectives. The research phase took roughly six times longer than anticipated, partly due to a year-long obstacle through URR and IRB. I also estimated the data collection process incorrectly due to unforeseen weather interference and idealistic views of analysis procedures. The delays during the data collection and analyses were not as severe because I was able to remain focused. As the project developed, the timeline became less important because as a practitioner, the significance of the needs assessment was to estimate deficiencies within the department (Royse et al., 2009) and to report the findings so the district could affect change, not maintain a specific timeline.

Analysis of Self as Project Developer

As the project designer of this study, I learned to adapt while affecting change within my immediate surroundings. While at my residency I found it quite difficult to choose a project, as I had never been in the position where my research had the ability to affect change within the school. During that residency I came to the full realization that as the sole project developer, I must plan, develop, and implement my research without the assistance of other researchers. I felt overwhelmed by the daunting task ahead. I followed the guidance of influential researchers in the fields of program evaluations and needs assessment. As the project evolved, so did my competency in developing and conducting a mixed methods program evaluation.

The Project's Potential Impact on Social Change

The emergence of a restructured science curriculum is a form of educational self-renewal for QRS High School where the students can employ their surroundings to adapt and overcome oversights they may have in subject matter (Dewey, 1916). Science teachers must be skilled in their discipline to provide students with basic inquiry tools so those students may successfully complete their coursework. In terms of social change, which can address everyday issues, the critical thinking associated with inquiry instruction (Dolan & Grady, 2010; Grady, 2010) could help students face new challenges, allowing them "inclusiveness and sustainability [who], ultimately, values the individual, society, humanity and the environment at large" (Elliott, Fourali, & Issler, 2010, p. 1). This statement illustrates social change involves small modifications to effect a large change in the lives of those a person encounters every day.

The findings and recommendations from the needs assessment address social change on the local level as well as the larger educational community. At the local level, this study encourages science teachers to participate in ongoing inquiry as a method to increase student proficiency in science, thus generating locally competitive students for college and the workforce. This study could also initiate the process for data driven changes within all departments at QRS High School and the QRS School District.

In terms of the larger educational community, there are a number of states opting to mandate a high school exit exam. For example, Missouri is implementing ACT testing for all public school students in grade 11 starting with the 2014-2015 school year (DESE, 2014). This should demonstrate proficiency in math, English, reading, and science. ACT, Inc. (2007, 2008, 2009a, 2009b, 2010a,) substantiated that taking the ACT is an appropriate assessment to measure college readiness through the raw scores, benchmark standards, and the composite score. Thus, the use of the ACT in all 50 states as a high school exit exam would be a foundation for a national common assessment where college readiness benchmarks could assist students in their transition to college. Furthermore, the use of the ACT as a national test could possibly assist in streamlining NAEP. The use of college readiness benchmarks from the ACT can provide data "based on actual student performance in a nationally representative sample" (ACT, 2011g, p.4). The recommendations from this study to help students at QRS High School acquire the necessary skills now for future ACT tests could transfer to other districts so their students could take a nationally mandated test with a successful outcome.

Implications, Applications, and Directions for Future Research

The anticipated outcome for this study was to provide substantial baseline data for the QRS High School science department so the department could make appropriate modifications to the curriculum. The results from this study revealed that the average student science ACT scores were below the college readiness standard; teachers employ a slightly above average amount of inquiry; teachers cover roughly 60% of the science ACT standards in the classroom, but were inconsistent with which standards were covered in courses taught by multiple teachers; and teachers felt open-ended inquiry is useful in the science classroom, but they need time for professional development, collaboration and preparation, and implementation. As such, science teachers should apply the recommendations from this study in classrooms so the department can evaluate benchmarks to determine the success of modifications. As discussed earlier, the recommendations included focusing on instructional needs, identifying instructional goals, and comparing curriculum content and expectations (ACT, 2006); covering more NGSS and ACT standards; using more ISIS inquiry techniques; incorporating more hands-on activities and cross-curricular tasks; and using collaboration time and research-based models to implement these inclusions. If applied, these recommendations could enrich the science program.

I designed this evaluation to specifically identify deficiencies within the science department. Although I only produced the evaluation for the science department, other departments could utilize the general design of the evaluation to determine deficiencies or inconsistencies between teachers of the same course. Future research could include semiannual, annual, or bi-annual evaluations to monitor the achievement of benchmark goals, which could then be updated if reached. Additional opportunities for research would include similar school districts conducting the needs assessment to determine if results are comparable.

Conclusion

This project study involving the effectiveness of the science curriculum produced important discourse within the academic community concerning high school scientific skill attainment. Although this study was considered a small scale study with limited generalizability, the effect within the science department at QRS High School could be remarkable. The evaluation revealed deficiencies that were affecting both teacher performance and student acquisition of skills and provided recommendations to correct these. Furthermore, this study mirrored the school's mission to provide exemplary learning and was one action in an attempt to increase student success. The strength of the evaluation was the mixed methods methodology, but was limited by my novice status as a program evaluator and my deficient statistical data analysis training. Being propelled in to a role as scholar, project developer, and practitioner altered my perception of the impact I have on school policy, leadership, program evaluation, and research within the academic community to affect social change.

References

Achieve, Inc. (2014). DCI arrangement of standards. Retrieved from http://www.nextgenscience.org/search-standards-dci

ACT. (2006). Curriculum review worksheets. Retrieved from http://act.org/standard/instruct/pdf/CurriculumReviewWorksheets.pdf

ACT. (2007). The ACT technical manual. Retrieved from http://www.act.org/aap/pdf/ACT_Technical_Manual.pdf

ACT. (2008). Issues in college success: The relative predictive validity of ACT scores and high school grades in making college admission decisions. Retrieved from http://www.act.org/research/policymakers/pdf/PredictiveValidity.pdf

ACT. (2009a). ACT national curriculum survey 2009. Retrieved from http://www.act.org/research/policymakers/pdf/NationalCurriculumSurvey2009.pdf

ACT. (2009b). Focusing on the essentials for college and career readiness: Policy implications of the ACT national curriculum survey results 2009. Retrieved from http://www.act.org/research/policymakers/pdf/NCS_PolicySummary2009.pdf

ACT. (2010a). The condition of college & career readiness 2010. Retrieved from http://www.act.org/research/policymakers/cccr10/pdf/ConditionofCollegeandCareerReadiness2010.pdf

ACT. (2010b). The condition of college & career readiness 2010: Missouri. Retrieved from http://www.act.org/news/data/10/pdf/readiness/CCCR_Missouri.pdf?utm_campaign=cccr10&utm_source=data10&utm_medium=web

ACT. (2011a). ACT profile report-high school: Graduating class 2011 Saint Clair High School. ACT, Inc.

ACT. (2011b). ACT profile report-state: Graduating class 2011 Missouri. Retrieved from http://www.act.org/newsroom/data/2011/pdf/profile/Missouri.pdf

ACT. (2011c). Affirming the goal: Is college and career readiness an internationally competitive standard?. Retrieved from http://www.act.org/research/policymakers/pdf/AffirmingtheGoal.pdf

ACT. (2011d). Affirming the goal: Is college and career readiness an internationally competitive standard? Executive summary. Retrieved from http://www.act.org/research/policymakers/pdf/AffirmingSummary.pdf

ACT. (2011e). Affirming the goal: Is college and career readiness an internationally competitive standard? Advance brief for state policymakers. Retrieved from http://www.act.org/research/policymakers/pdf/AffirmingAdvanceBrief.pdf

ACT. (2011f). Breaking new ground: Building a national workforce skills credentialing system. Retrieved from http://www.act.org/research/policymakers/pdf/BreakingNewGround.pdf

ACT. (2011g). Technical manual for the PLAN-PISA international benchmarking linking study. Retrieved from http://www.act.org/research/policymakers/pdf/PLAN_PISA_TechManual.pdf

ACT. (2012). The condition of college & career readiness 2012. Retrieved from http://media.act.org/documents/CCCR12-NationalReadinessRpt.pdf

ACT. (2013a). The condition of college & career readiness 2013. Retrieved from http://www.act.org/research/policymakers/cccr13/pdf/CCCR13-NationalReadinessRpt.pdf

ACT. (2013b) Description of the ACT. Retrieved from http://www.actstudent.org/testprep/descriptions/

ACT. (2014). ACT college career readiness standards—science. Retrieved from http://www.act.org/standard/planact/science/index.html

Aladejana, F. F. (2009). Blended learning and technology-assisted teaching of Biology in Nigerian secondary schools. *AIP Conference Proceedings*, *1127*133-140. doi:10.1063/1.3146184

Ali, S. R., Yang, L-Y., Button, C. J., & McCoy, T. T. H. (2011). Career education programming in three diverse high schools: A critical psychology-case study research approach. *Journal of Career Development*, 39(4), 357-385. doi:10.1177/0894845311398131

Alkharusi, H. (2010). Teachers' assessment practices and students' perceptions of the classroom assessment environment. *World Journal on Educational Technology*, *2*(1), 27-41. doi:10.1016/j.sbspro.2010.07.041

Allen, R. (2007). *The essentials of science, grades 7-12: Effective curriculum, instruction, and assessment*. Alexandria, VA: Association for Supervision & Curriculum Development.

Altschuld, J. W. & Kumar, D. D. (2010). *Needs assessment: An overview*. Thousand Oaks, CA: Sage.

Alvarez, S. A., & Barney, J. B. (2013). Entrepreneurial opportunities and poverty alleviation. *Entrepreneurship Theory and Practice*, *38*(1), 159-184. doi:10.1111/etap.12078

American Association for the Advancement of Science. (2013a). AAAS project 2061 Biology textbook evaluation: Criteria for evaluating the quality of instructional support. Retrieved from http://www.project2061.org/publications/textbook/hsbio/summary/criteria.htm

American Association for the Advancement of Science. (2013b). Education: Project 2061. Retrieved from http://www.project2061.org/default.htm

Asunda, P. A. (2011). Open courseware and STEM initiatives in career and technical education. *Journal of Stem Teacher Education*, *48*(2), 6-37. Retrieved from http://scholar.lib.vt.edu/ejournals/JSTE/v48n2/pdf/asunda.pdf

Aurentz, D. J., Kerns, S. L., & Shibley, L. R. (2011). Improving student perceptions of science through the use of state-of-the-art instrumentation in general chemistry laboratory. *Journal of College Science Teaching*, *40*(6), 12-17. Retrieved from http://search.proquest.com/docview/873895913?accountid=14872

Baine, C. (n.d.). Women and minorities in STEM careers advancing our world. Retrieved from https://www.mheonline.com/glencoemath/pdf/stem_careers.pdf

Blanchard, M. R., Southerland, S. A., Osborne, J. W., Sampson, V. D., Annetta, L. A., & Granger, E. M. (2010). Is inquiry possible in light of accountability?: A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction. *Science Education*, *94*(4), 577-616. doi:10.1002/sce.20390

Bloom, B. (1985). *Developing talent in young people*. New York, NY: Ballantine Books.

Bolden, M. G. (2012). *Reforming high school science for low-performing students using inquiry methods and communities of practice*. (Doctoral dissertation). Retrieved from Dissertations & Theses: Full Text. (Publication No. 961669654).

Bowers, A. (2007).*Grades and data-driven decision making: Issues of variance and student patterns.* (Doctoral dissertation). Retrieved from Dissertations & Theses: Full Text. (Publication No. AAT 3264143).

Brandon, P. R., Young, D. B., Pottenger, F. M., & Taum, A.K. (2009). The inquiry science implementation scale: Development and applications. *International Journal of Science and Mathematics Education, 7*(6), 1135-1147. doi:10.1007/s10763-009-9156-0

Brickman, P., Gormally, C., Armstrong, N., & Hallar, B. (2009). Effects of inquiry based learning on students' science literacy skills and confidence. *International Journal for the Scholarship of Teaching and Learning, 3*(2), 1-22. Retrieved from http://www.eric.ed.gov/PDFS/EJ938575.pdf

Brookfield, S. D. (2010). *Developing critical thinkers: Challenging adults to explore alternative ways of thinking and acting*. San Francisco, CA: Jossey-Bass.

Burton, E., & Frazier, W. (2012). Voices from the front lines: Exemplary science teachers on education reform. *School Science and Mathematics*, *112*(3), 179-190. doi:10.1111/j.1949-8594.2011.00131.x

Bybee, R. W. Taylor, J.A., Gardner, A., Scotter, P. V., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. A report prepared for the Office of Science Education National Institutes of Health. Retrieved from http://science.education.nih.gov/houseofreps.nsf/b82d55fa138783c2852572c9004f5566/$FILE/Appendix%20D.pdf

Bybee, R. W. (2007). Science teaching and international assessments. *Science Teacher*, *74*(8), 41-48. Retrieved from http://www.nsta.org

Bybee, R. W. (2009). Program for International Student Assessment (PISA) 2006 and scientific literacy: A perspective for science education leaders. *Science Educator*, *18*(2), 1-13. Retrieved from http://www.eric.ed.gov/PDFS/EJ864610.pdf

Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: Perspectives from PISA 2006 Science. *International Journal of Science Education*, *33*(1), 7-26. doi:10.1080/09500693.2010.518644

Bybee, R. W. (2013). *Translating the NGSS for classroom instruction*. [Electronic version]. Arlington, VA: National Science Teachers Association Press. Retrieved from http://cires.colorado.edu/education/outreach/workshops/NGSS/Baybee-Rodger.pdf

Campbell, R., Gregory, K. A., Patterson, D., & Bybee, D. (2012). Integrating qualitative and quantitative approaches: An example of mixed methods research. In J. Leonard & D. Glenwick (Eds), *Methodological approaches to community-based* research (pp. 51-68). Washington, DC: American Psychological Association. doi:10.1037/13492-004

Capraro, R. M., Capraro, M. M., & Morgan, J. (2013). *Other books: STEM project-based learning: An integrated Science, Technology, Engineering, and Mathematics (STEM) approach*. (2nd ed.). [Electronic version]. Rotterdam, Netherlands: Sense Publishers. Retrieved from http://site.ebrary.com/lib/waldenu/reader.action?docID=10697078

Center for the Future of Teaching and Learning. (2011). *Scientific Literacy: The Missing Ingredient*. Retrieved from http://www.eric.ed.gov/PDFS/ED516005.pdf

Chabalengula, V., Mumba, F., Hunter, W. J., & Wilson, E. (2009). A model for assessing students' science process skills during science lab work. *Problems of Education in the 21st Century*, 11(2), 28-36. Retrieved from Education Research Complete database. (Accession No. 40399278)

Changing Minds. (2013). t-test. Retrieved from http://changingminds.org/explanations/research/analysis/t-test.htm

Chen, H. X. (2012). *Approaches to quantitative research: A guide for dissertation students*. [Electronic version]. Cork, Ireland: Oak Tree Press. Retrieved from http://site.ebrary.com/lib/waldenu/detail.action?docID=10810216

Condon, C., Greenberg, A., Stephan, J., Williams, R., Gerdeman, R., Molefe, A., & ... Regional Educational Laboratory Midwest. (2012). Performance in science on the Minnesota Comprehensive Assessments—Series II for students in grades 5 and 8. Issues & answers. REL 2012-No. 138. *Regional Educational Laboratory Midwest*. Retrieved from http://files.eric.ed.gov/fulltext/ED531420.pdf

Cothern, R. L. (2012). *Inquiry based instruction and high stakes testing.* (Doctoral dissertation). Retrieved from Dissertations & Theses: Full Text. (Publication No. 917227340).

Creghan, K. A. & Creghan, C. (2013). Assessing for achievement. *Science and Children*, *51*(3), 29-35. Retrieved from http://www.nsta.org

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Pearson Education.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative and mixed methods approaches* (3rd ed). Thousand Oaks, CA: Sage.

Danielson, C. (2007). *Enhancing professional practice: A framework for teaching* (2nd ed.). Alexandria, VA: Association for Supervision & Curriculum Development.

Datnow, A., Solorzano, D. G., Watford, T., & Park, V. (2010). Mapping the terrain: The state of knowledge regarding low-income youth access to postsecondary education. *Journal of Education For Students Placed At Risk*, *15*(1/2), 1-8. doi:10.1080/10824661003634898

Deming, J. C., O'Donnell, J. R., & Malone, C. J. (2012). Scientific literacy: Resurrecting the phoenix with thinking skills. *Science Educator*, *21*(2), 10-17. Retrieved from http://course1.winona.edu/cmalone/Promotion/Publications/Scientific%20Literacy%20with%20Deming.pdf

Dewey, J. (1916). *Democracy and Education*. [Electronic version]. Project Gutenberg. Retrieved from http://library.um.ac.id/images/stories/ebooks/Juni10/democracy%20and%20education%20-%20john%20dewey.pdf.

Dolan, E., & Grady, J. (2010). Recognizing students' scientific reasoning: A tool for categorizing complexity of reasoning during teaching by inquiry. *Journal of Science Teacher Education*, *21*(1), 31-55. doi:10.1007/s10972-009-9154-7

Duffy, F. M. (2010). *Dream! Create! Sustain!: Mastering the art and science of transforming school systems.* Lanham, MD: Rowman & Littlefield Education.

Eberle, F. (2010, September/October). Why STEM education is important. *ISA: InTech*. Retrieved from http://www.isa.org/InTechTemplate.cfm?template=/ContentManagement/ContentDisplay.cfm&ContentID=83593

Eisenkraft, A. (2003). Expanding the 5E model: A proposed 7E model emphasizes "transfer of learning" and the importance of eliciting prior understanding. *The Science Teacher*, 70(6), 56-59. Retrieved from http://emp.byui.edu/firestonel/bio405/readings/learning%20models/expanding%205e.pdf

Elliott, G., Fourali, C., & Issler, S. (2010). *Education and social change: Connection local and global perspectives*. London, England: Continuum International Publishing.

Feller, R. (2011). Advancing the STEM workforce through stem-centric career development. *Technology and Engineering Teacher*, *71*(1), 6-12. Retrieved from http://eds.b.ebscohost.com

Fink, A. (2009). *How to conduct surveys* (4th ed.). Thousand Oaks, CA: Sage.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs—principles and practices. *Health services research*, *48*(6pt2), 2134-2156. doi:10.1111/1475-6773.12117

Fleischman, H.L., Hopstock, P.J., Pelczar, M.P., & Shelley, B.E. (2010). *Highlights from PISA 2009: Performance of U.S. 15-year old students in reading, mathematics, and science literacy in an international context* (NCES 2011-004). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Retrieved from http://nces.ed.gov/pubs2011/2011004.pdf

Foster, J. S., & Shiel-Rolle, N. (2011). Building scientific literacy through summer science camps: A strategy for design, implementation and assessment. *Science Education International*, *22*(2), 85-98. Retrieved from http://eds.b.ebscohost.com

Furgol, K., Fina, A., & Welch, C. (2011, April). *Establishing validity evidence to assess college readiness through a vertical scale.* Paper presented at the Annual Meeting of the National Council on Measurement in Education, New Orleans, LA. Paper retrieved from http://itp.education.uiowa.edu/downloads/Establishing%20Validity%20Evidence%20to%20Assess%20College%20Readiness%20through%20a%20Vertical%20Scale.pdf

Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE Life Science Education, 11,* 364-377. doi:10.1187/cbe.12-03-0026

Gopalsingh, B. (2010). Teacher perceptions of high school students' underachievement in science. (Doctoral dissertation). Retrieved from Dissertations & Theses: Full Text. (Publication No. AAT 3412508).

Grady, J. (2010). The inquiry matrix: A tool for assessing and planning inquiry in Biology and beyond. *Science Teacher*, *77*(8), 32-37. Retrieved from http://www.nsta.org

Green, S. B., & Salkind, N. J. (2011). *Using SPSS for Windows and Macintosh: Analyzing and understanding data* (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Guzzetti, B. J., & Bang, E. (2011). The influence of literacy-based science instruction on adolescents' interest, participation, and achievement in science. *Literacy Research and Instruction*, *50*(1), 44-67. doi:10.1080/19388070903447774

Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. *Science*, *332*(6034), 1213-1216. doi:10.1126/science.1204820

Hall, C., Dickerson, J., Batts, D., Kauffmann, P., & Bosse, M. (2011). Are we missing opportunities to encourage interest in stem fields? *Journal of Technology Education*, *23*(1), 32-46. Retrieved from http://scholar.lib.vt.edu/ejournals/JTE/v23n1/hall.html

Hardré, P. L., Davis, K. A., & Sullivan, D. W. (2008a). Measuring teacher perceptions of the "how" and "why" of student motivation. *Educational Research and Evaluation*, 14(2), 155-179. doi:10.1080/13803610801956689

Hardré, P. L., Sullivan, D. W., & Roberts, N. (2008b). Rural teachers' best motivating strategies: A blending of teachers' and students' perspectives. *Rural Educator*, 30(1), 19-31. Retrieved from http://eds.b.ebscohost.com

Hardré, P. L., Sullivan, D. W., & Crowson, H. (2009). Student characteristics and motivation in rural high schools. *Journal of Research in Rural Education, 24*(16), 1-19. Retrieved from http://www.jrre.psu.edu/articles/24-16.pdf

Hesse-Biber, S. N. (2010). *Mixed methods research: Merging theory with practice*. [Electronic version]. New York, NY: Guilford Press. Retrieved from http://site.ebrary.com/lib/waldenu/reader.action?docID=10356628

Howard, R. D., McLaughlin, G. W., & Knight, W. E. (2012). *Handbook of institutional research*. [Electronic version]. Somerset, NJ: Wiley. Retrieved from http://site.ebrary.com/lib/waldenu/reader.action?docID=10575645

IBM. (2012). IBM SPSS statistics 21. [Computer software CD].

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods*, *18*(1), 3-20. doi:10.1177/1525822X05282260

Jensen, P. A., & Moore, R. (2008). Do students' grades in high school biology accurately predict their grades in college biology? *Journal of College Science Teaching*, *37*(3), 62-65. Retrieved from http://eds.b.ebscohost.com

Johnson, C. C. (2009). An examination of effective practice: Moving toward elimination of achievement gaps in science. *Journal of Science Teacher Education*, *20*(3), 287-306. doi:10.1007/s10972-009-9134-y.

Johnson, C. C., Zhang, D., Kahle, J. B., & Broomfield, C. O. (2012). Effective science instruction: Impact on high-stakes assessment performance. RMLE Online, 35(9), 1-14. Retrieved from http://www.amle.org/portals/0/pdf/publications/RMLE/rmle_vol35_no9.pdf

Joughin, G. (Ed.). (2009). *Assessment, learning and judgment in higher education.* Dordrecht, Netherlands: Springer.

Justice, C., Rice, J., Roy, D., Hudspith, B., & Jenkins, H. (2009). Inquiry based learning in higher education: Administrators' perspectives on integrating inquiry pedagogy into the curriculum. *Higher Education*, *58*(6), 841-855. doi:10.1007/s10734-009-9228-7

Kellaghan, T., Greaney, V., & Murray, T. S. (2009). *National assessment of educational achievement, volume 5: Using the results of a national assessment of educational achievement.* Herndon, VA: World Bank Publications.

Kelly, B. (2012, September 21). The state of STEM and jobs. *U.S. News and World Report*. Retrieved from http://www.usnews.com/news/articles/2012/09/21/the-state-of-stem-and-jobs_print.html

King, S. B., & West, D. (2009). Statewide articulation agreements between high schools and community college career and technical programs. *Community College Journal of Research & Practice, 33*(6), 527-532. doi:10.1080/10668920802662438

Koba, S. B., Wojnowski, B. S., & Yager, R. E. (2013). *Exemplary science: Best practices in professional development* (2nd ed.). Arlington VA: National Science Teachers Association.

Lee, V. E., & Ready, D. D. (2009). U.S. high school curriculum: Three phases of contemporary research and reform. *Future of Children*, 19(1), 135-156. Retrieved from https://www.princeton.edu/futureofchildren/publications/docs/19_01_07.pdf

Lemke, C., & Coughlin, E. (2009). The change agents. *Educational Leadership*, 67(1), 54-59. Retrieved from http://eds.b.ebscohost.com.ezp.waldenulibrary.org/eds/pdfviewer/pdfviewer?sid=d7198f52-2f54-4c3d-b037-3934019cb358%40sessionmgr113&vid=8&hid=120

Lenth, R. V. (2001). Some practical guidelines for effective sample size determination. *The American Statistician*, 55(3), 187-193. doi:10.1198/000313001317098149

Lenth, R. V. (2009). Java Applets for Power and Sample Size [Computer software]. Retrieved from http://www.stat.uiowa.edu/~rlenth/Power.

Lindsey, D. B., Jungwirth, L. D., Pahl, J. V. N. C., & Lindsey, R. (2009). *Culturally proficient learning communities: Confronting inequities through collaborative curiosity.* Thousand Oaks, CA: Sage.

Liu, O., Lee, H., & Linn, M. C. (2010). Multifaceted assessment of inquiry based science learning. *Educational Assessment*, *15*(2), 69-86. doi:10.1080/10627197.2010.491067

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2006). *Methods in educational research: From theory to practice*. San Francisco, CA: Jossey-Bass.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). Program evaluation in education. In *Methods in educational research: From theory to practice* (2nd ed.). [Electronic version]. Hoboken, NJ: Jossey-Bass. Retrieved from http://site.ebrary.com/lib/waldenu/detail.action?docID=10381048

Marshall, J. C., & Horton, R. M. (2011). The relationship of teacher-facilitated, inquiry based instruction to student higher-order thinking. *School Science and Mathematics*, *111*(3), 93-101. doi:10.1111/j.1949-8594.2010.00066.x

Martin, W. E. & Bridgmon, K. D. (2012). *Quantitative and statistical research methods: From hypothesis to results*. [Electronic version]. Somerset, NJ: John Wiley & Sons. Retrieved from http://books.google.com/books

Marzano, R. (2003). *What works in schools: Translating research into action*. Alexandria, VA: Association for Supervision & Curriculum Development.

McDonald, J. H. (2009). *Handbook of biological statistics* (2nd ed.). Baltimore, MD: Sparky House Publishing.

McKinney, K. H. & Taylor, M. (2012). *Scholarship of teaching and learning in and across the disciplines.* [Electronic version]. Bloomington, IN: Indiana University Press. Retrieved from http://site.ebrary.com/lib/waldenu/detail.action?docID=10636963

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation.* San Francisco, CA: Jossey-Bass.

Mertens, D. M. & Wilson, A. T. (2012). *Program evaluation theory and practice: A comprehensive guide*. [Electronic version]. New York, NY: Guilford Press.

Mertens, D. M. & Hesse-Biber, S. (2013). *Mixed methods and credibility of evidence in evaluation: New directions for evaluation.* [Electronic version]. Somerset, NJ: John Wiley & Sons. Retrieved from http://site.ebrary.com/lib/waldenu/reader.action?docID=10539287

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching*, *47*(4), 474-496. doi:10.1002/tea.20347

Miranda, R. J. & Hermann, R. S. (2012). An integrated instructional approach to facilitate inquiry in the classroom. *Science Scope,* 35(8) 66-72. Retrieved from http://learningcenter.nsta.org/files/ss1208_66.pdf

Missouri Department of Elementary and Secondary Education. (2010a). 2009-10 school accountability report card: St. Clair R-XIII school district (036136). Retrieved from http://dese.mo.gov/planning/profile/building/arsd0361361050.html

Missouri Department of Elementary and Secondary Education. (2010b). Annual report of school data: American College Test (ACT) 2006-2010. Retrieved from http://dese.mo.gov/planning/profile/AC036136.html

Missouri Department of Elementary and Secondary Education. (2010c). Annual report of school data: Demographic data, 2006-2010. Retrieved from http://dese.mo.gov/planning/profile/DD036136.html

Missouri Department of Elementary and Secondary Education. (2010d). Annual report of school data: Graduate analysis, 2006-2010. Retrieved from http://dese.mo.gov/planning/profile/GF036136.html

Missouri Department of Elementary and Secondary Education. (2014). Frequently asked questions 2014-2015 ACT® administration. Retrieved from http://dese.mo.gov/sites/default/files/ACT%20FAQ%205-28-14.pdf

Mo, L., Yang, F., Hu, X., Calaway, F., & Nickey, J. (2011). ACT test performance by advanced placement students in Memphis city schools. *Journal of Educational Research*, *104*(5), 354-359. doi:10.1080/00220671.2010.486810

Montague, N. R. (2012). Articulation agreements: No credits left behind. *Issues in Accounting Education*, *27*(1), 281-298. doi:10.2308/iace-10218

Murphy, J. (2009). Closing achievement gaps: Lessons from the last 15 years. (Cover story). *Phi Delta Kappan*, 91(3), 8-12. doi:10.1177/003172170909100303

Nagowah, L., & Nagowah, S. (2009). A reflection on the dominant learning theories: Behaviorism, cognitivism and constructivism. *International Journal of Learning*, 16(2), 279-285. Retrieved from http://ijl.cgpublisher.com/product/pub.30/prod.2056

National Center for Educational Achievement (NCEA) and ACT, Inc. (2011). The 20 non-negotiable characteristics of higher performing school systems. ACT report. Retrieved from http://www.act.org/research-policy/policy-publications/

National Center for Education Statistics. (2012). The nation's report card: Science 2011. National Assessment of Educational Progress at Grade 8. (NCES 2012-465). *Institute of Education Sciences, U.S. Department of Education, Washington, D.C.* Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012465

National High School Center. (2006). At a glance: NCLB and high schools. Policy brief. Retrieved from http://www.betterhighschools.org/pubs/documents/NCLBandHighSchoolsFactSheet_081806.pdf

National Institutes of Health. (2012). How do clinical trials protect participants?. Retrieved from http://www.nhlbi.nih.gov/health/health-topics/topics/clinicaltrials/protect.html

National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. (2013). Needs assessment training. Retrieved from http://www.csc.noaa.gov/needs/

National Research Council (1996). *National science education standards*. Washington, D.C.: National Academy Press.

National Research Council. (2000a). *How people learn: Brain, mind, experience, and school* (expanded ed). Washington, D.C.: National Academy Press.

National Research Council. (2000b). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, D.C.: National Academy Press.

National Research Council. (2005). *America's lab report: Investigations in high school science*. Washington, D.C.: National Academy Press.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, D.C.: National Academy Press. Retrieved from http://download.nap.edu/cart/download.cgi?&record_id=13165&free=1

National Science Teachers Association (NSTA). (n.d.). BSCS 5E instructional model. Retrieved from learningcenter.nsta.org/files/PB186X-4.pdf

Newby, L., & Winterbottom, M. (2011). Can research homework provide a vehicle for assessment for learning in science lessons?. *Educational Review*, *63*(3), 275-290. doi:10.1080/00131911.2011.560247

Office of Social and Economic Data Analysis. (2011). 2010 Missouri kids count. Retrieved from http://mcdc2.missouri.edu/pub/webrepts/kidscnt/outcomes_facts/29071.html

Patel, R. N. (2010). *Program evaluation: Theory and practice*. Mumbai, IND: Global Media.

Pearson, D., Sawyer, J., Park, T., Santamaria, L., van der Mandele, E., Keene, B., & ... National Research Center for Career and Technical Education. (2010). Capitalizing on context: Curriculum integration in career and technical education. A joint report of the NRCCTE curriculum integration workgroup. *National Research Center for Career and Technical Education*. Retrieved from http://www.eric.ed.gov/PDFS/ED510267.pdf

Perry, G. E., Arias, O. A., López, J. H., Maloney, W. F., & Servén, L. (2006). The relative roles of growth and inequality for poverty reduction. In (no Ed.), *Poverty reduction and growth: virtuous and vicious circles* (pp. 57-73). Herndon, VA: World Bank Publications.

Piaget, J. (2009). La causalité chez l'enfant (Children's understanding of causality)... Reprinted from The British Journal of Psychology (1928), 18, 276-301. *British Journal of Psychology*, *100*(Part 1a), 207-224. doi:10.1348/000712608X336059

Pickard, A. J. (2013). *Research methods in information*. London, England: Facet Publishing.

Polikoff, M. S. (2012). Instructional alignment under No Child Left Behind. *American Journal of Education*, *118*(3), 341-368. doi:http://dx.doi.org/10.1086/664773

Quinn, G. W. (2010). *Improving test scores in five easy steps*. Lanham, MD: Rowman & Littlefield Publishing Group.

Quinn, F., & Lyons, T. (2011). High school students' perceptions of school science and science careers: A critical look at a critical issue. *Science Education International*, *22*(4), 225-238. Retrieved from http://www.eric.ed.gov/PDFS/EJ962811.pdf

Riordan, T. & Loacker, G. (2009). Collaborative and systemic assessment of student learning: From theory to practice. In G. Joughin (Ed.), *Assessment, learning and judgment in higher education* (pp. 175-192). Dordrecht, Netherlands: Springer.

Roberson, C., & Lankford, D. (2010). Laboratory notebooks in the science classroom. *Science Teacher*, *77*(1), 38-42. Retrieved from http://www.nsta.org

Royse, D. D., Staton-Tindall, M., Badger, K., & Webster, J. M. (2009). *Needs assessment.* [Electronic version]. Cary, NC: Oxford University Press. Retrieved from http://site.ebrary.com/lib/waldenu/reader.action?docID=10288445

Sawyer, R. (2010). Usefulness of high school average and ACT scores in making college admission decisions. (ACT Research Report No. 2010-2). Retrieved from http://www.act.org/research/researchers/reports/pdf/ACT_RR2010-2.pdf

Schiavelli, M. (2011, November 3). STEM jobs outlook strong, but collaboration needed to fill jobs. *U.S. News and World Report*. Retrieved from http://www.usnews.com/news/blogs/stem-education/2011/11/03/stem-jobs-outlook-strong-but-collaboration-needed-to-fill-jobs

Schmoker, M. (1993). Transforming schools through total quality education. *Phi Delta Kappan*, 74(5), 389-394. Retrieved from http://www.jstor.org

Schmoker, M. J. (2006). *Results now: How we can achieve unprecedented improvements in teaching and learning*. Alexandria, VA: Association for Supervision & Curriculum Development.

Schmoker, M. (2007a). Radically redefining literacy instruction: An immense opportunity. *Phi Delta Kappan*, 88(7), 488-493. Retrieved from http://www.ccs.k12.in.us/uploads/news/0000/0321/schmoker.pdf

Schmoker, M. (2007b). Reading, writing, and thinking for all: Critical thinking, cultural awareness, impassioned writing. These skills aren't just for the college bound. *Educational Leadership*, 64(7), 63-66. Retrieved from http://www.gatesfoundation.org/edextranet/Documents/LiteracyConveningreadingwritingthinking.pdf

Schmoker, M. (2008). Measuring what matters. *Educational Leadership*, 66(4), 70-74. Retrieved from http://eds.b.ebscohost.com

Schmoker, M. (2009). What money can't buy: Powerful, overlooked, opportunities for learning. *Phi Delta Kappan*, 90(7), 524-527. Retrieved from http://www.vassp.org/schmoker%20what%20money%20can%27t%20buy.pdf

Schmoker, M. (2011). Hiding in plain sight. *Phi Delta Kappan*, 93(1), 68-69. Retrieved from http://www.jstor.org

Schombert, J. (2010). Introductory Astronomy as a measure of grade inflation. Retrieved from http://www.citeulike.org/group/10888/article/7717555

Scott, P., & Pentecost, T. C. (2013). From verification to guided inquiry: What happens when a chemistry laboratory curriculum changes? *Journal of College Science*

Teaching, *42*(3), 82-88. Retrieved from http://eds.b.ebscohost.com.ezp.waldenulibrary.org/eds/pdfviewer/pdfviewer?sid=d7198f52-2f54-4c3d-b037-3934019cb358%40sessionmgr113&vid=34&hid=120

Sheninger, E. C. & Devereaux, K. (2012). *What principals need to know: What principals need to know about teaching and learning science* (2nd ed.). Bloomington, IN: Solution Tree Press.

Sherwood, H. (2010). A school counseling program evaluation: Utilizing staff perceptions to guide and shape future program planning. *Georgia School Counselors Association Journal*, 17(1), 15- 25. Retrieved from http://files.eric.ed.gov/fulltext/EJ909074.pdfERIC

Shymansky, J. A., Kyle, W. C., & Alpert, J. (1982). Research synthesis on the science curriculum projects of the sixties. *Educational Leadership*, *40*(1), 63-66. Retrieved from http://www.ascd.org/ASCD/pdf/journals/ed_lead/el_198210_shymansky.pdf

Shymansky, J. A., Kyle, W. C., & Alpert, J. (1983). The effects of new science curricula on student performance. *Journal of Research in Science Teaching,* 20(5), 387-404. doi:10.1002/tea.3660200504

Shymansky, J. A., Kyle, W. C., & Alpert, J. (2003). The effects of new science curricula on student performance. *Journal of Research in Science Teaching,* 40(1), 68-85. doi:10.1002/tea.3660200504

Shymansky, J. A., Yore, L. D., Annetta, L. A., & Everett, S. A. (2008). Missouri-Iowa Science Cooperative (Science Co-Op): Rural schools-urban universities collaborative project. *Rural Educator*, *29*(2), 1-3. Retrieved from http://www.ruraleducator.net/archive/29-2/29-2_Brief.pdf

Simpson, J. (2009). In a crisis, our nation must have an ambitious education strategy. *Chronicle of Higher Education, 55*(28), A72-A72. Retrieved from http://eds.b.ebscohost.com

Spaulding, D. T. (2008). *Program evaluation in practice: Core concepts and examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

St. Clair Area Chamber of Commerce. (2008). Economic development. Retrieved November 12, 2011 from http://stclairmo.com/stclairmo/economic.htm

St. Clair High School. (2013). ACT information. Retrieved from http://stclair.fesdev.org/vnews/display.v/ART/2008/09/09/48c91ef7e7e5a

Sulaiman, T., Hassan, A., & Yi, H. (2011). An analysis of teaching styles in primary and secondary school teachers based on the theory of multiple intelligences. *Journal of Social Sciences, 7*(3), 428-435. Retrieved from http://thescipub.com/PDF/jssp.2011.428.435.pdf

Sungur, S., & Güngören, S. (2009). The role of classroom environment perceptions in self-regulated learning and science achievement. *Ilkogretim Online*, *8*(3), 883-899. Retrieved from http://ilkogretim-online.org.tr/vol8say3/v8s3m19.pdf

Tavakolian, H., & Howell, N. (2012). The impact of No Child Left Behind Act. *Franklin Business & Law Journal*, (1), 70-77. Retrieved from http://eds.b.ebscohost.com.

Torgesen, J.K., & Miller, D.H.(2009). *Assessments to guide adolescent literacy instruction.* Portsmouth, NH: Center on Instruction at RMC Research

Corporation. Retrieved from http://centeroninstruction.org/files/Assessment%20Guide.pdf

Trauth-Nare, A., & Buck, G. (2011). Assessment "for" learning: Using formative assessment in problem- and project-based learning. *Science Teacher*, *78*(1), 34-39. Retrieved from http://www.nsta.org

Tugel, J., & Porter, I. (2010). Uncovering student thinking in science through CTS action research. *Science Scope*, *34*(1), 30-36. Retrieved from http://www.nsta.org

Vernon-Feagans, L., Gallagher, K. C., & Kainz, K. (2010). The transition to school in rural America. In. J. Meece (Ed.), *Handbook of Research on Schools, Schooling, and Human Development*. Florence, KY: Routledge.

Visone, J. D. (2010). Science or reading: What is being measured by standardized tests?. *American Secondary Education*, *39*(1), 95-112. Retrieved from https://www.questia.com/library/journal/1P3-2198903721/science-or-reading-what-is-being-measured-by-standardized

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, England: Harvard University Press.

Wagner, T. (2008). *The global achievement gap*. New York, NY: Basic Books.

Walsh, P. (2010). Does competition among schools encourage grade inflation? *Journal of School Choice*, *4*(2), 149-173. doi:10.1080/15582159.2010.483918

Weld, J., Stier, M., & McNew-Birren, J. (2011). The development of a novel measure of scientific reasoning growth among college freshmen: The constructive inquiry science reasoning skills test. *Journal of College Science Teaching*, *40*(4), 101-107. Retrieved from http://eds.b.ebscohost.com

Yin, R. K. (2009). Student achievement data and findings, as reported in math and science partnerships' annual and evaluation reports. *Journal of Educational Research & Policy Studies*, *9*(2), 141-163. Retrieved from http://files.eric.ed.gov/fulltext/EJ896286.pdf

Yin, R. K. (2011). *Qualitative research from start to finish.* [Electronic version]. New York, NY: The Guilford Press.

Yin, R. K. (2014). *Case study research: Design and methods*. [Electronic version]. Thousand Oaks, CA: SAGE Publications, Inc.

Yoshikawa, H., Weisner, T. S., Kalil, A., & Way, N. (2013). Mixing qualitative and quantitative research in developmental science: Uses and methodological choices. *Qualitative Psychology, 1*(S), 3-18. doi:10.1037/2326-3598.1.S.3

Zhe, J., Doverspike, D., Zhao, J., Lam, P., & Menzemer, C. (2010). High school bridge program: A multidisciplinary STEM research program. *Journal of STEM Education: Innovations and Research*, *11*(1-2), 61-68. Retrieved from http://eds.b.ebscohost.com

Appendix A: Evaluation Findings, Recommendations, and Presentation of Findings

An Overview of Evaluation Findings

A mixed methods program evaluation allowed the collection of both quantitative and qualitative data, revealing numerous important findings. Quantitative data included ACT background statistics from 2007 to 2011, presenting school, state, and national level data (no individual student records); individual past student ACT scores from 2008-2013; a curriculum check of ACT Science College Readiness Standards employed in each science course, which are skills assessed by the ACT; and 22 classroom level inquiry-practices in science as measured on The inquiry science implementation scale (ISIS). The qualitative component consisted of individual interviews. Fundamentally, quantitative data confirmed average student ACT scores below the college readiness standard of 23 (lowered from a 24 within the last two years). The data indicated teachers employ a slightly above average amount of inquiry and science ACT standards in the classroom, but were inconsistent with which standards were covered in courses taught by multiple teachers. The qualitative data revealed that teachers feel open-ended inquiry is useful in the science classroom, but need time to become skilled, collaborate and prepare, and implement inquiry in the classroom.

The data from the program evaluation helped to make the recommendations for the science department. While data established that students are not testing above the amount of inquiry and ACT standards applied in the classroom, the recommendation is for the science teachers to increase the amount of inquiry usage and ACT standards within the curriculum from 60% to 75%, hopefully resulting in average science ACT scores that increase to college readiness. Therefore, a transformation of the science curriculum in an effort to increase science skills is deemed necessary. A transformed science curriculum will take the entire department with: consideration for the students, factors affecting students as individuals, and the way the students learn. I propose the science department work as a cohesive unit to focus on instructional needs, identify instructional goals, and compare curriculum content and expectations using the ACT curriculum review worksheets to produce the following, tentative, inclusions for the science curriculum: (a) covering more Next Generation of Science Standards (NGSS) and ACT standards, (b) using more ISIS inquiry techniques, (c) incorporating more hands-on activities, (d) conducting more cross-curricular tasks, and the use of (e) collaboration time and (f) the 5E instructional model as techniques to implement these inclusions.

Methodology and Data

I used a mixed methods research design for this program evaluation. Mixed methods research allows a researcher to gather quantitative and qualitative data, providing both answers and understanding for research questions. In particular, this evaluation collected quantitative data first and qualitative data second.

ACT Data

An analysis of ACT scores by gender showed males scored slightly higher in science and the composite scores. The frequency numbers indicated a mode of 21 for males, 35 students, and 20 for females, 44 students. This information is indicated in Figure 1 by the solid line of the bottleneck; the median was 22 for males and 20 for females.

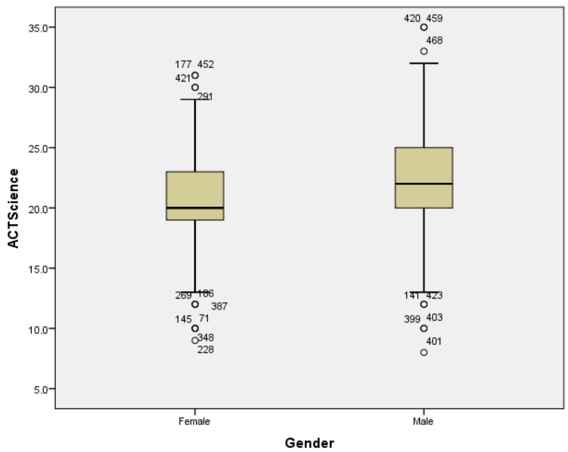


Figure 1. Stem and leaf plot showing science ACT scores by gender.

Numbers for the composite score are similar (Figure 2) where the median is 21 for both males and females. However, these numbers are below the ACT college readiness standard in science.

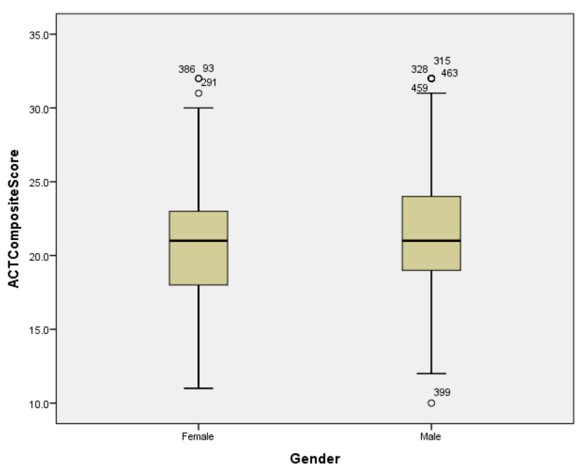


Figure 2. Stem and leaf plot showing composite ACT scores by gender.

Furthermore, frequency data verified that 63.1% of students did not meet the college readiness standard in science and 73.8% of the students scored a 23 or less on the composite score.

Inquiry Science Implementation Scale (ISIS) Data

The ISIS survey consists of 22 inquiry related questions to determine the frequency science teachers implement inquiry in the classroom. Frequency data determined that 44% of the science teachers use inquiry *sometimes to often*, which equates to anywhere from the low end of a 3, 30%, to the high end of a 4, 74%, on the 5-point scale.

ACT Workbook Data Findings

The original ACT workbook data the science teachers completed contained 47 items assessed during the ACT. I asked the teachers to fill out the workbook survey for each course taught. There were three questions per item. The ACT workbook data illustrated a significant decline in coverage between the 20-23 and 24-28 score categories. ACT workbook data also revealed an inconsistency within courses that are taught by multiple teachers. More specifically, Physical Science courses do not cover the same assessed items in five of the six score categories; in the top four score categories there is as much as a 55 to 87.5% difference. Biology courses experience the same variation in coverage, although consistency begins to diminish at the 24-27 score category.

Interview Data

Time was the central theme of the nine interview questions. Teachers need time to apply the following, teacher suggested, action agendas: (a) attend workshops where the focus is on scientific inquiry and learning how to enhance inquiry techniques in the classroom, (b) meet with other science teachers within the department to produce inquiry units, and (c) apply inquiry units in the curriculum. However, time is finite and limited time appears to emerge as the source of hindrance within the science department. Therefore, the suggested application for these agendas is on professional development days, the week after school is released for summer, and the week before school is back in session; the school district would most likely have to pay for the extra two weeks as those days are not contracted days for the district. This strategy would reduce the number of days teachers are out of their classrooms, thus increasing the number of days in which inquiry units could be applied in the curriculum.

Recommendations Based on Findings

Given the strengths and weakness discovered within the science department, I generated recommendations from the findings to improve student skill achievement.

1. Utilize the 5E/7E instructional model, which is a student-centered inquiry model appropriate for use in science classrooms. The model is based on constructivism and, by name, focuses on 5 *E* phases for learning science: *engagement, exploration, explanation, elaboration*, and *evaluation* but can also include *elicit* and *extend*. The 5E/7E instructional model can provide science teachers with a cohesive, hands-on, approach to inquiry learning.

2. Include more hands-on learning opportunities in science classrooms. Efforts discussed by researchers to improve the science skills in science include such items as (a) creating a real-world curriculum, (b) having businesses help determine what students need to learn, (c) participating in more hands-on activities, (d) having guest speakers in STEM careers, (e) performing activities that use collaboration, (f) selecting problem solving coursework, and (g) integrating more technology. These techniques encourage

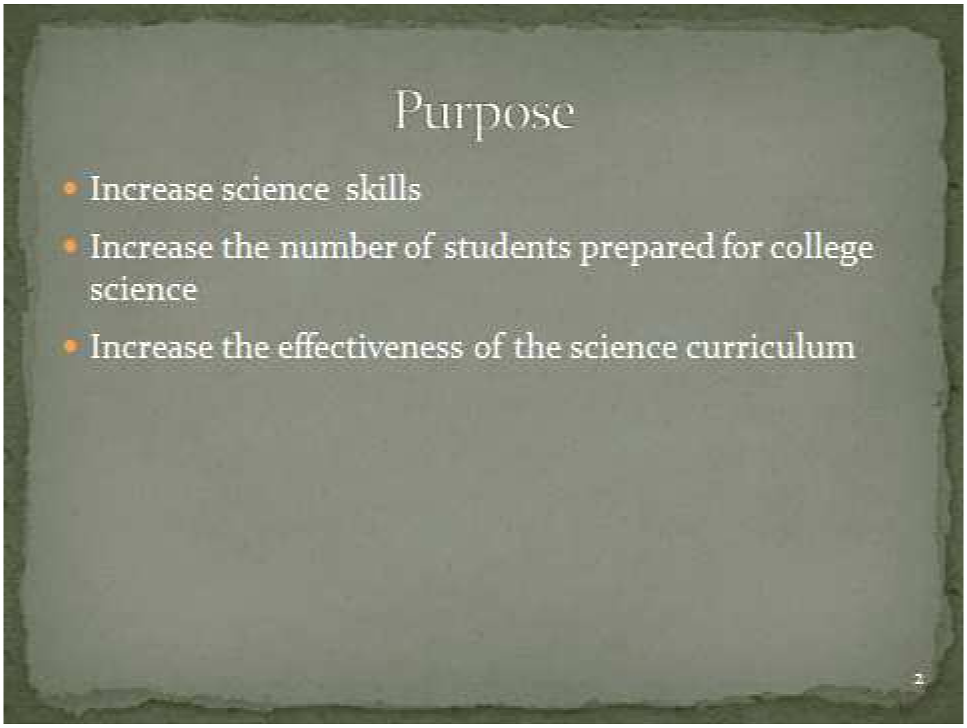
students to become successful academic learners and take an active role in their own education.

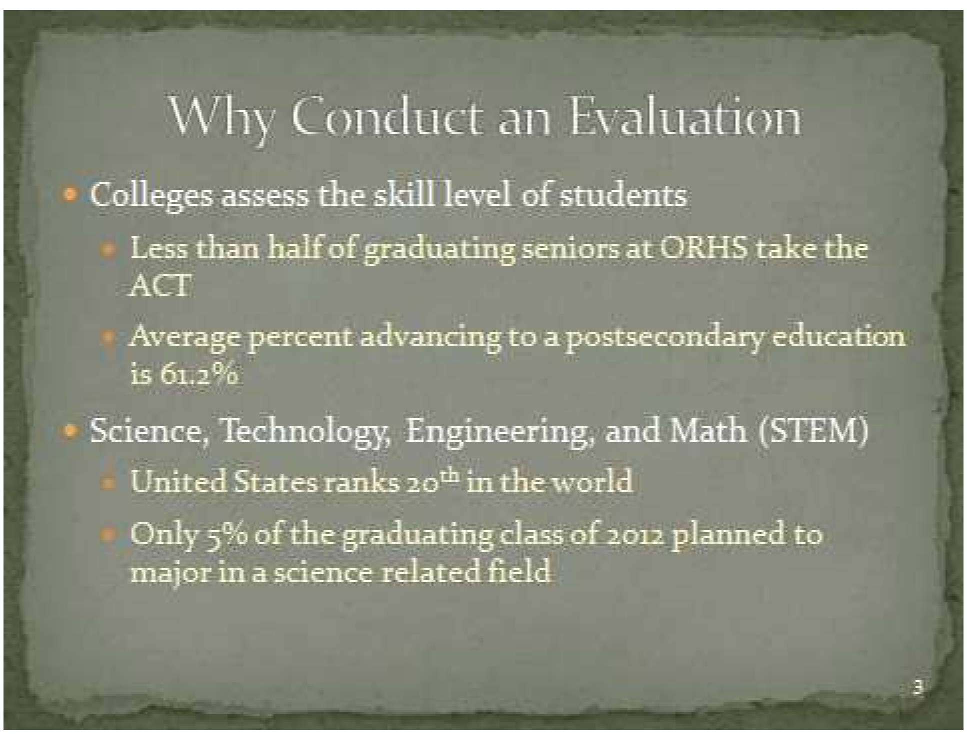
3. More curriculum integration, both horizontal and cross-curricular. This could help with the cognitive and literacy skills needed in science. Interdisciplinary instruction helps students obtain all necessary skills so the students may increase their academic output. Teachers must increase the literacy level if they expect students to do well on assessments. Research has shown that cross-curricular integration improves teacher-teacher and student-student interaction while building relationships, aiding in curriculum and program reviews, and providing interactive competitive opportunities.

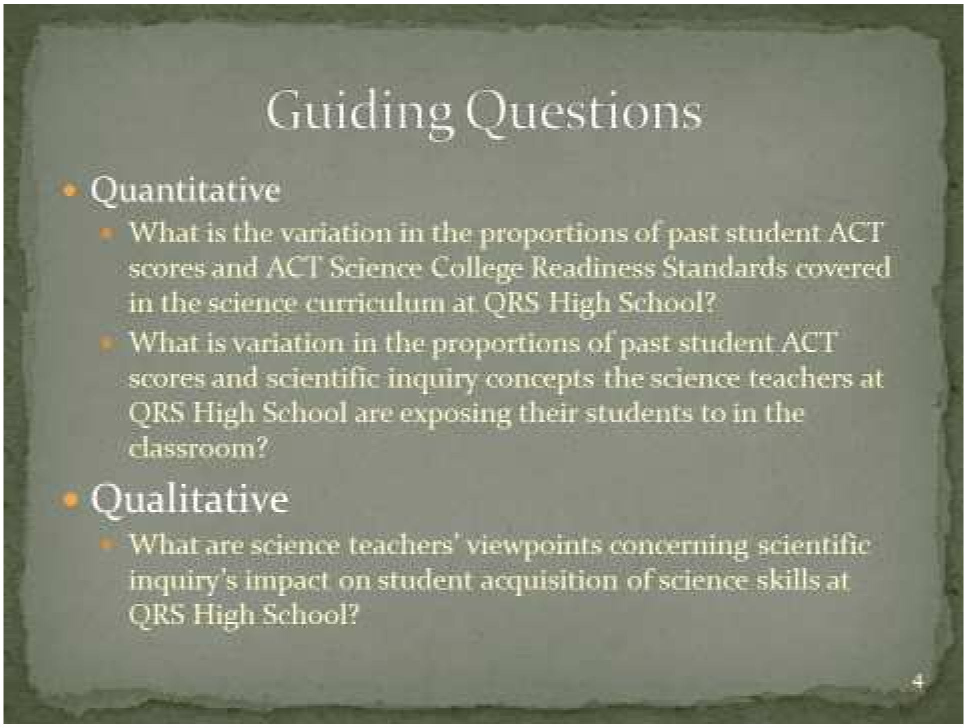
4. Increase the number of ACT concepts and NGSS covered in the science curriculum. For over 50 years, ACT scores have been considered a reliable predictor for college readiness and first-year college success. Based on the data analysis, less than 40% of students meet college readiness standards in science. Recall, students need a 23 benchmark score in science to be considered college ready. The science department would need to choose which standards should to cover, and the courses they should be covered in.

5. Involvement in professional learning communities (PLC), or small learning community (SLC), and professional development; opportunities outside the classroom can aid revitalization within the classroom. PLCs could support change, provide the science department with a clear and shared vision, and help the department adapt and share practices. A PLC or SLC could help the science department confront discrepancies revealed during the data analysis.

Slide Presentation of Findings






Guiding Questions
Quantitative
What is the variation in the proportions of past student ACT scores and ACT Science College Readiness Standards covered in the science curriculum at QRS High School?
What is variation in the proportions of past student ACT scores and scientific inquiry concepts the science teachers at QRS High School are exposing their students to in the classroom?
Qualitative
What are science teachers' viewpoints concerning scientific inquiry's impact on student acquisition of science skills at QRS High School?
4


Research Design
Explanatory mixed methods program evaluation
Needs Assessment
Three phases involved
Preassessment
Assessment
Postassessment
5

Data Collection

- Quantitative Data--explanatory research
  - Student Records
    - Past ACT scores = 469 students
  - Survey 1
    - Inquiry Science Implementation Scale (ISIS)
  - Survey 2
    - ACT Science College Readiness Standards from the Curriculum Review Worksheets Workbook

6

Data Collection

- Qualitative Data—Case Study
  - Interview
    - 9 questions

7

Research Findings

- ACT Data
  - Science Average
    - Males = 22
    - Females = 20
  - Composite Score Average
    - Males = 21
    - Females = 21
  - College readiness standard
    - Science = 63.1% below
    - Composite = 73.8% below a 23

8

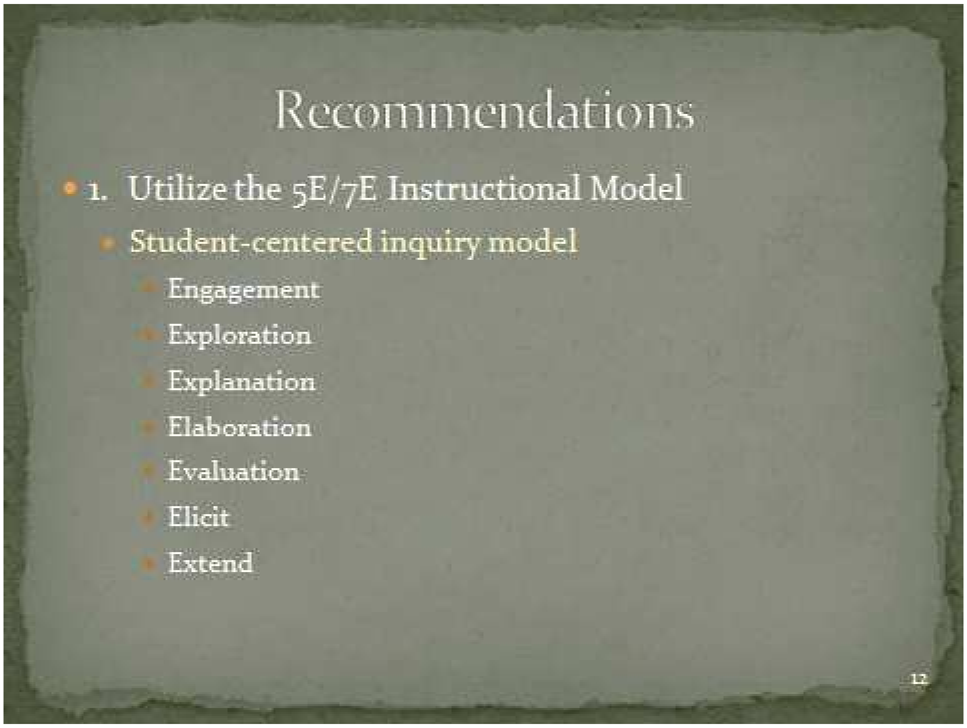
Research Findings

- The Inquiry Science Implementation Scale (ISIS)
  - Average
    - 3.6 on a 5-point scale
  - Usage
    - 44% = *sometimes to often*

9

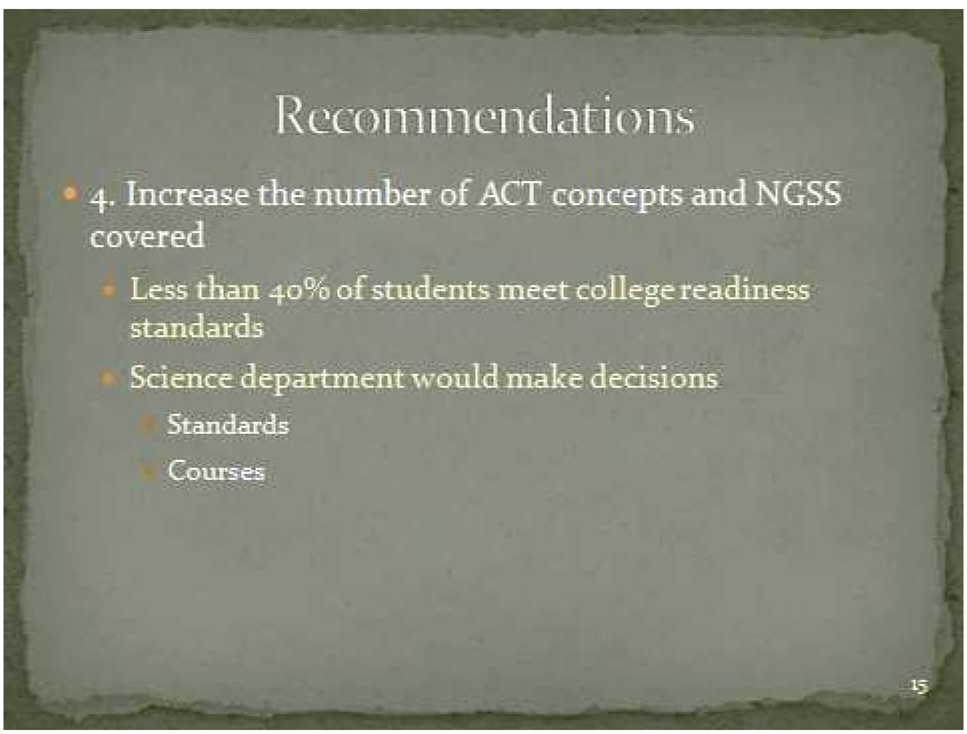

Research Findings
ACT Workbook Data
47 items assessed
Three sub-questions per item
Significant decline in coverage
Between the 20-23 and 24-28 score categories
Inconsistency within course
Physical Science = 5 out of 6 categories
Biology = 4 out of 6 categories
10

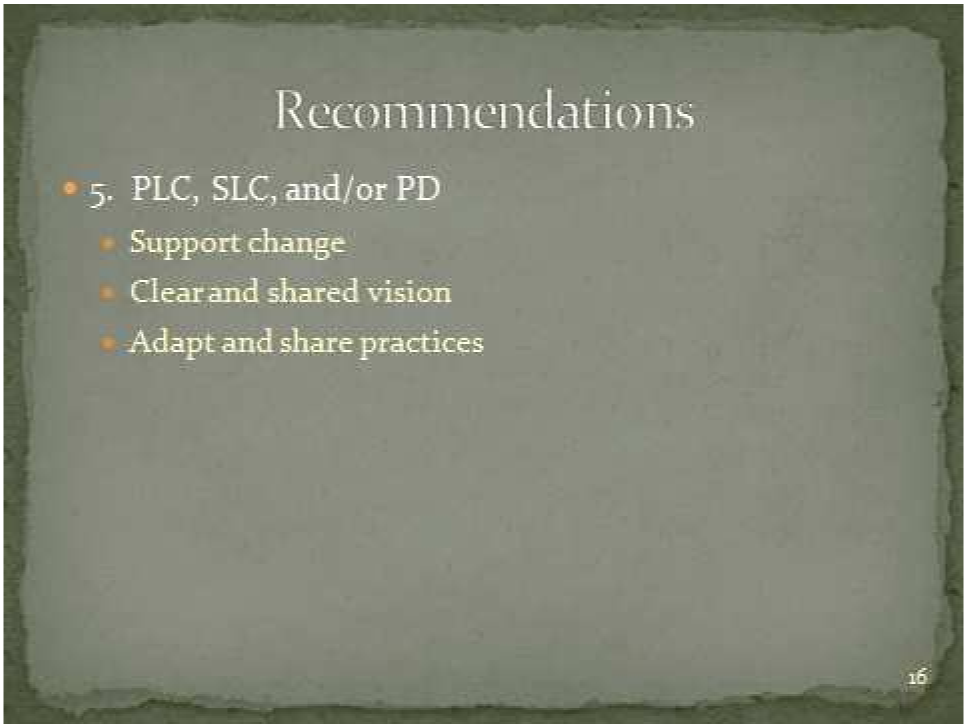

Research Findings
Interview Data
Central Theme = Time
Attend workshops that focus on
Scientific inquiry
Learning how to enhance inquiry techniques in the classroom
Collaboration time
Application of units
When to implement
Professional development days
Week after school
Week before school
11


Recommendations
1. Utilize the 5E/7E Instructional Model
Student-centered inquiry model
Engagement
Exploration
Explanation
Elaboration
Evaluation
Elicit
Extend
12


Recommendations
2. More hands-on learning opportunities
Real-world curriculum
Have businesses help determine student needs
Have guest speakers in STEM careers
Perform activities that use collaboration
Select problem solving coursework
Integrate more technology
13


Recommendations
3. More curriculum integration
Curricular
Cross-Curricular
Help increase the literacy level
Improve interaction
Teacher-Teacher
Student-Student
Student-Teacher
14


Recommendations
4. Increase the number of ACT concepts and NGSS covered
Less than 40% of students meet college readiness standards
Science department would make decisions
Standards
Courses
15


Recommendations
5. PLC, SLC, and/or PD
Support change
Clear and shared vision
Adapt and share practices
16


Questions and Comments
Thank You
17

Appendix B: ACT Background Data

5 Year Trends--ACT Comparison Data

Year	Scores		
	School	State	National
Percent of Students Meeting Science College Readiness Benchmarks			
2007	18.0	31.0	28.0
2008	20.0	31.0	28.0
2009	27.0	32.0	28.0
2010	25.0	32.0	29.0
2011	17.0	32.0	30.0
Average	21.4	31.6	28.6
Average Science ACT Scores			
2007	20.2	21.5	21.0
2008	19.9	21.4	20.8
2009	20.9	21.5	20.9
2010	21.3	21.6	20.9
2011	20.8	21.6	20.9
Average	20.6	21.5	20.9
Number of students taking the ACT			
2007	97	45,354	1,300,599
2008	105	47,240	1,421,941
2009	92	46,923	1,480,469
2010	105	48,290	1,568,835
2011	94	48,565	1,623,112
Average	98.6	47,274.4	1,478,991.2

Note. From "ACT profile report-high school: Graduating class 2011 QRS High School," by ACT, Inc., 2011. School level data reprinted with permission.

Appendix C: Letter from ACT to use the Curriculum Review Worksheets Workbook

Cathy Robertson,
PERMISSION #0026-0413A

ACT grants you the use of the Curriculum Review Worksheets http://act.org/standard/instruct/pdf/curriculumreviewworsheets.pdf in connection with your doctoral study. You may copy and use subject to the conditions below.

a) acknowledge ACT's ownership of the items by printing on at least the first page/web screen of your document: "Copyright ACT, Inc. [2006]. Used with permission of ACT, Inc."

b) The permission is granted for a period of five years (from January 1, 2013, through December 31, 2017) and for the purpose listed above only.

c) Neither you nor your institution shall sell or permit other parties to use the instrument containing the ACT items without ACT's written consent.
Kind Regards.

Cyndi Showalter
Senior Director, Third Party Certification and Licensing
500 ACT Drive, P O Box 168
Iowa City IA 52234-0168
319.337.1458

ACT improveyourself.org

This email message is intended only for the personal use of the recipient(s) named above. If you are not an intended recipient, you may not review, copy or distribute this message. If you have received this communication in error, please notify the sender immediately by email and delete the original message.

From: Cathy Robertson [redacted]
Sent: Thursday, April 11, 2013 8:30 AM
To: ACT Publications
Subject: Doctoral Paper for Cathy Robertson

Hello,

My name is Cathy Robertson and I am a doctoral student with Walden University. The topic of the project study through the university is a program evaluation of the science department curriculum where I work, a low-income high school in rural Missouri. While looking online, I found the "Curriculum Review Worksheets" booklet at http://act.org/standard/instruct/pdf/CurriculumReviewWorksheets.pdf
I would like to formally ask if I may reproduce and use the figures and tables dealing with science in my doctoral study. The information for science can be found on pg. 1 and pgs. 20-25.

Thank you for your time.

Cathy Robertson
[redacted]

Appendix D: ACT Science College Readiness Standards from the Curriculum Review Worksheets Workbook: Copyright ACT, Inc. [2006]. Used with permission of ACT, Inc.

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)			
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)			

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation			
Understand basic scientific terminology			
Find basic information in a brief body of text			

Determine how the value of one variable changes as the value of another variable changes in a simple data presentation			
Understand the methods and tools used in a simple experiment			

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)			
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)			
Translate information into a table, graph, or diagram			
Understand the methods and tools used in a moderately complex experiment			
Understand a simple experimental design			
Identify a control in an experiment			
Identify similarities and differences between experiments			

Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model			
Identify key issues or assumptions in a model			

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)			
Compare or combine data from a complex data presentation			
Interpolate between data points in a table or graph			
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation			
Identify and/or use a simple (e.g., linear) mathematical relationship between data			
Analyze given information when presented with new, simple information			
Understand the methods and tools used in a complex experiment			

Understand a complex experimental design			
Predict the results of an additional trial or measurement in an experiment			
Determine the experimental conditions that would produce specified results			
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models			
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why			
Identify strengths and weaknesses in one or more models			
Identify similarities and differences between models			
Determine which model(s) is(are) supported or weakened by new information			
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion			

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?

Compare or combine data from a simple data presentation with data from a complex data presentation			
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data			
Extrapolate from data points in a table or graph			
Determine the hypothesis for an experiment			
Identify an alternate method for testing a hypothesis			
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model			
Determine whether new information supports or weakens a model, and why			
Use new information to make a prediction based on a model			

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations			

Analyze given information when presented with new, complex information			
Understand precision and accuracy issues			
Predict how modifying the design or methods of an experiment will affect results			
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results			
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models			
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why			

Note. Adapted from "Curriculum Review Worksheets," by ACT, Inc. 2006, pp. 20-25.

Appendix E: ACT Science College Readiness Standards from the Curriculum Review Worksheets Workbook: Raw Data

Respondent 1

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Life Skills Science	Life Skills Science
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Life Skills Science	Life Skills Science

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Life Skills Science	Life Skills Science
Understand basic scientific terminology	Yes	Life Skills Science	Life Skills Science
Find basic information in a brief body of text	Yes	Life Skills Science	Life Skills Science

Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Life Skills Science	Life Skills Science
Understand the methods and tools used in a simple experiment	Yes	Life Skills Science	Life Skills Science

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	No		
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Life Skills Science	Life Skills Science
Translate information into a table, graph, or diagram	Yes	Life Skills Science	Life Skills Science
Understand the methods and tools used in a moderately complex experiment	No		
Understand a simple experimental design	Yes	Life Skills Science	Life Skills Science
Identify a control in an experiment	No		
Identify similarities and differences between experiments	Yes	Life Skills Science	Life Skills Science

Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Life Skills Science	Life Skills Science
Identify key issues or assumptions in a model	Yes	Life Skills Science	Life Skills Science

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No		
Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	No		
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	No		
Analyze given information when presented with new, simple information	Yes	Life Skills Science	Life Skills Science
Understand the methods and tools used in a complex experiment	No		

Understand a complex experimental design			
Predict the results of an additional trial or measurement in an experiment	Yes	Life Skills Science	Life Skills Science
Determine the experimental conditions that would produce specified results	No		
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Life Skills Science	Life Skills Science
Identify strengths and weaknesses in one or more models			
Identify similarities and differences between models	Yes	Life Skills Science	Life Skills Science
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	No		

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?

Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	No		
Determine the hypothesis for an experiment	Yes	Life Skills Science	Life Skills Science
Identify an alternate method for testing a hypothesis	No		
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	Yes	Life Skills Science	Life Skills Science

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		

Analyze given information when presented with new, complex information	No		
Understand precision and accuracy issues	No		
Predict how modifying the design or methods of an experiment will affect results	No		
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 2

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Already Introduced	Physical Science
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Already Introduced	Physical Science

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Already Introduced	Physical Science
Understand basic scientific terminology	Yes	Already Introduced	Physical Science
Find basic information in a brief body of text	Yes	Already Introduced	Physical Science
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Already Introduced	Physical Science
Understand the methods and tools used in a simple experiment	Yes	Already Introduced	Physical Science

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Physical Science	Post Physical Science

Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Physical Science	Post Physical Science
Translate information into a table, graph, or diagram	Yes	Physical Science	Post Physical Science
Understand the methods and tools used in a moderately complex experiment	Yes	Physical Science	Post Physical Science
Understand a simple experimental design	Yes	Physical Science	Post Physical Science
Identify a control in an experiment	Yes	Physical Science	Post Physical Science
Identify similarities and differences between experiments	Yes	Physical Science	Post Physical Science
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Physical Science	Post Physical Science
Identify key issues or assumptions in a model	Yes	Physical Science	Post Physical Science

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No		

Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	No		
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Physical Science	Post Physical Science
Analyze given information when presented with new, simple information	Yes	Physical Science	Post Physical Science
Understand the methods and tools used in a complex experiment	No		
Understand a complex experimental design	No		
Predict the results of an additional trial or measurement in an experiment	Yes	Physical Science	Physical Science
Determine the experimental conditions that would produce specified results	No		
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	No		

Identify strengths and weaknesses in one or more models	No		
Identify similarities and differences between models	No		
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	No		

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	No		
Determine the hypothesis for an experiment	Yes	Physical Science	Physical Science
Identify an alternate method for testing a hypothesis	Yes	Physical Science	Post Physical Science

Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		
Analyze given information when presented with new, complex information	No		
Understand precision and accuracy issues	No		
Predict how modifying the design or methods of an experiment will affect results	No		
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		

Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 3

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Biology	Biology and Biotechnology
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Biology	Biology and Biotechnology

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Biology	Biology and Biotechnology
Understand basic scientific terminology	Yes	Biology	Biology and Biotechnology

Find basic information in a brief body of text	Yes	Biology	Biology and Biotechnology
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Biology	Biology and Biotechnology
Understand the methods and tools used in a simple experiment	Yes	Biology	Biology and Biotechnology

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Biology	Biology and Biotechnology
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Biology	Biology and Biotechnology
Translate information into a table, graph, or diagram	Yes	Biology	Biology and Biotechnology
Understand the methods and tools used in a moderately complex experiment	Yes	Biology	Biology and Biotechnology
Understand a simple experimental design	Yes	Biology	Biology and Biotechnology
Identify a control in an experiment	Yes	Biology	Biology and Biotechnology

Identify similarities and differences between experiments	Yes	Biology	Biology and Biotechnology
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Biology	Biology and Biotechnology
Identify key issues or assumptions in a model	Yes	Biology	Biology and Biotechnology

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	Yes	Biotechnology	Biotechnology
Compare or combine data from a complex data presentation	Yes	Biotechnology	Biotechnology
Interpolate between data points in a table or graph	Yes	Biotechnology	Biotechnology
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	Yes	Biotechnology	Biotechnology
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Biotechnology	Biotechnology
Analyze given information when presented with new, simple information	Yes	Biotechnology	Biotechnology

Understand the methods and tools used in a complex experiment	Yes	Biotechnology	Biotechnology
Understand a complex experimental design	Yes	Biotechnology	Biotechnology
Predict the results of an additional trial or measurement in an experiment	Yes	Biotechnology	Biotechnology
Determine the experimental conditions that would produce specified results	Yes	Biotechnology	Biotechnology
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Biology	Biology and Biotechnology
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Biology	Biology and Biotechnology
Identify strengths and weaknesses in one or more models	Yes	Biotechnology	Biotechnology
Identify similarities and differences between models	Yes	Biotechnology	Biotechnology
Determine which model(s) is(are) supported or weakened by new information	Yes	Biotechnology	Biotechnology
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Biotechnology	Biotechnology

Science College Readiness Standards for Score Range 28-32	
Science Standards	For each skill, knowledge, or process:

	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	Yes	Biotechnology	Biotechnology
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	Yes	Biotechnology	Biotechnology
Extrapolate from data points in a table or graph	Yes	Biology	Biology and Biotechnology
Determine the hypothesis for an experiment	Yes	Biology	Biology and Biotechnology
Identify an alternate method for testing a hypothesis	Yes	Biology	Biology and Biotechnology
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	Yes	Biotechnology	Biotechnology
Determine whether new information supports or weakens a model, and why	Yes	Biotechnology	Biotechnology
Use new information to make a prediction based on a model	Yes	Biotechnology	Biotechnology

Science College Readiness Standards for Score Range 33-36	
Science Standards	For each skill, knowledge, or process:

	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	Yes	Biotechnology	Biotechnology
Analyze given information when presented with new, complex information	Yes	Biotechnology	Biotechnology
Understand precision and accuracy issues	Yes	Biotechnology	Biotechnology
Predict how modifying the design or methods of an experiment will affect results	Yes	Biotechnology	Biotechnology
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Yes	Biology	Biology and Biotechnology
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Biotechnology	Biotechnology
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	Yes	Biology	Biology and Biotechnology

Respondent 4

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?

Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Physical Science	Biology
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Physical Science	Biology
Understand basic scientific terminology	Yes	Physical Science	Biology
Find basic information in a brief body of text	Yes	Physical Science	Biology
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Physical Science	Physical Science
Understand the methods and tools used in a simple experiment	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Physical Science	Biology
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Physical Science	Biology
Translate information into a table, graph, or diagram	Yes	Physical Science	Biology
Understand the methods and tools used in a moderately complex experiment	No		
Understand a simple experimental design	Yes	Physical Science	Biology
Identify a control in an experiment	Yes	Physical Science	Biology
Identify similarities and differences between experiments	Yes	Physical Science	Biology
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Physical Science	Biology
Identify key issues or assumptions in a model	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No		
Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	No		
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	No		
Analyze given information when presented with new, simple information	No		
Understand the methods and tools used in a complex experiment	No		
Understand a complex experimental design	No		
Predict the results of an additional trial or measurement in an experiment	No		

Determine the experimental conditions that would produce specified results	No		
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	No		
Identify strengths and weaknesses in one or more models	No		
Identify similarities and differences between models	No		
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	No		

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		

Extrapolate from data points in a table or graph	No		
Determine the hypothesis for an experiment	No		
Identify an alternate method for testing a hypothesis	No		
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		
Analyze given information when presented with new, complex information	No		
Understand precision and accuracy issues	No		

Predict how modifying the design or methods of an experiment will affect results	No		
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 5

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Biology	Biology
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Physical Science	Biology
Understand basic scientific terminology	Yes	Physical Science	Biology
Find basic information in a brief body of text	Yes	Physical Science	Biology
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Physical Science	Biology
Understand the methods and tools used in a simple experiment	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Physical Science	Biology

Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Physical Science	Biology
Translate information into a table, graph, or diagram	Yes	Physical Science	Biology
Understand the methods and tools used in a moderately complex experiment	Yes	Physical Science	Biology
Understand a simple experimental design	Yes	Physical Science	Biology
Identify a control in an experiment	Yes	Physical Science	Biology
Identify similarities and differences between experiments	Yes	Physical Science	Biology
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Physical Science	Biology
Identify key issues or assumptions in a model	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	Yes	Physical Science	Biology

Compare or combine data from a complex data presentation	Yes	Physical Science	Biology
Interpolate between data points in a table or graph	Yes	Physical Science	Biology
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	No		
Analyze given information when presented with new, simple information	Yes	Physical Science	Biology
Understand the methods and tools used in a complex experiment	Yes	Physical Science	Biology
Understand a complex experimental design	Yes	Physical Science	Biology
Predict the results of an additional trial or measurement in an experiment	Yes	Physical Science	Biology
Determine the experimental conditions that would produce specified results	Yes	Physical Science	Biology
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Physical Science	Biology
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Physical Science	Biology

Identify strengths and weaknesses in one or more models	No		
Identify similarities and differences between models	No		
Determine which model(s) is(are) supported or weakened by new information	Yes	Physical Science	Biology
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	Yes	Physical Science	Biology
Extrapolate from data points in a table or graph	Yes	Physical Science	Biology
Determine the hypothesis for an experiment	Yes	Physical Science	Biology
Identify an alternate method for testing a hypothesis	Yes	Physical Science	Biology

Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	Yes	Physical Science	Biology
Determine whether new information supports or weakens a model, and why	Yes	Physical Science	Biology
Use new information to make a prediction based on a model	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	Yes	Physical Science	Biology
Analyze given information when presented with new, complex information	Yes	Physical Science	Biology
Understand precision and accuracy issues	No		
Predict how modifying the design or methods of an experiment will affect results	No		
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Yes	Physical Science	Biology
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Physical Science	Biology

Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	Yes	Physical Science	Biology

Respondent 6

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Already Introduced	Physical Science
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Already Introduced	Physical Science

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Already Introduced	Physical Science
Understand basic scientific terminology	Yes	Physical Science	Physical Science

Find basic information in a brief body of text	Yes	Physical Science	Physical Science
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Physical Science	Physical Science
Understand the methods and tools used in a simple experiment	Yes	Physical Science	Physical Science

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	No		
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Already Introduced	Physical Science
Translate information into a table, graph, or diagram	Yes	Already Introduced	Physical Science
Understand the methods and tools used in a moderately complex experiment	No		
Understand a simple experimental design	Yes	Physical Science	Physical Science
Identify a control in an experiment	Yes	Already Introduced	Physical Science

Identify similarities and differences between experiments	No		
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	No		
Identify key issues or assumptions in a model	No		

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No		
Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	Yes	Physical Science	Not Mastered in this course
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Physical Science	Not Mastered in this course
Analyze given information when presented with new, simple information	Yes	Physical Science	Physical Science

Understand the methods and tools used in a complex experiment	No		
Understand a complex experimental design	No		
Predict the results of an additional trial or measurement in an experiment	Yes	Physical Science	Not Mastered in this course
Determine the experimental conditions that would produce specified results	No		
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Physical Science	Physical Science
Identify strengths and weaknesses in one or more models	No		
Identify similarities and differences between models	Yes	Physical Science	Physical Science
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	No		

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	Yes	Physical Science	Not Mastered in this course
Determine the hypothesis for an experiment	Yes	Physical Science	Physical Science
Identify an alternate method for testing a hypothesis	No		
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		
Analyze given information when presented with new, complex information	No		
Understand precision and accuracy issues	No		
Predict how modifying the design or methods of an experiment will affect results	No		
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 7

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Already Introduced	Chemistry I
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Already Introduced	Chemistry I

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Already Introduced	Chemistry I
Understand basic scientific terminology	Yes	Chemistry I and Chemistry II	Chemistry I and Chemistry II
Find basic information in a brief body of text	Yes	Already Introduced	Chemistry I
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Already Introduced	Chemistry I

Understand the methods and tools used in a simple experiment	Yes	Already Introduced	Chemistry I

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Chemistry I	Chemistry I
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Already Introduced	Chemistry I
Translate information into a table, graph, or diagram	Yes	Already Introduced	Chemistry I
Understand the methods and tools used in a moderately complex experiment	Yes	Chemistry I	Chemistry I
Understand a simple experimental design	Yes	Already Introduced	Chemistry I
Identify a control in an experiment	Yes	Already Introduced	Already Mastered
Identify similarities and differences between experiments	Yes	Already Introduced	Chemistry I
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Already Introduced	Already Mastered

Identify key issues or assumptions in a model	Yes	Already Introduced	Chemistry I

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No		
Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	Yes	Already Introduced	Chemistry I
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Already Introduced	Chemistry I
Analyze given information when presented with new, simple information	Yes	Already Introduced	Chemistry I
Understand the methods and tools used in a complex experiment	Yes	Chemistry I	Chemistry II
Understand a complex experimental design	Yes	Chemistry II	Chemistry II

Predict the results of an additional trial or measurement in an experiment	Yes	Chemistry I	Chemistry II
Determine the experimental conditions that would produce specified results	No		
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Chemistry I	Chemistry II
Identify strengths and weaknesses in one or more models	Yes	Chemistry I	Chemistry II
Identify similarities and differences between models	Yes	Chemistry I	Chemistry I
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	No		

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		

Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	Yes	Chemistry I	Chemistry I
Determine the hypothesis for an experiment	Yes	Chemistry I	Chemistry I
Identify an alternate method for testing a hypothesis	Yes	Chemistry I	Chemistry I
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	Yes	Chemistry II	Chemistry II
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		
Analyze given information when presented with new, complex information	No		

Understand precision and accuracy issues	Yes	Chemistry II	Chemistry II
Predict how modifying the design or methods of an experiment will affect results	Yes	Chemistry I	Chemistry II
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Yes	Chemistry I	Chemistry II
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 8

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Already Introduced	Already Mastered
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Already Introduced	Already Mastered

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Already Introduced	Already Mastered
Understand basic scientific terminology	Yes	Dual Credit Geology	Dual Credit Geology
Find basic information in a brief body of text	Yes	Already Introduced	Already Mastered
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Already Introduced	Already Mastered
Understand the methods and tools used in a simple experiment	Yes	Already Introduced	Already Mastered

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Already Introduced	Dual Credit Geology

Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Already Introduced	Already Mastered
Translate information into a table, graph, or diagram	Yes	Already Introduced	Already Mastered
Understand the methods and tools used in a moderately complex experiment	Yes	Already Introduced	Dual Credit Geology
Understand a simple experimental design	Yes	Already Introduced	Already Mastered
Identify a control in an experiment	Yes	Already Introduced	Already Mastered
Identify similarities and differences between experiments	Yes	Already Introduced	Already Mastered
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Already Introduced	Already Mastered
Identify key issues or assumptions in a model	Yes	Already Introduced	Dual Credit Geology

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	Yes	Already Introduced	Already Mastered

Compare or combine data from a complex data presentation	No		
Interpolate between data points in a table or graph	Yes	Already Introduced	Already Mastered
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Already Introduced	Already Mastered
Analyze given information when presented with new, simple information	Yes	Already Introduced	Already Mastered
Understand the methods and tools used in a complex experiment	No		
Understand a complex experimental design	No		
Predict the results of an additional trial or measurement in an experiment	Yes	Already Introduced	Already Mastered
Determine the experimental conditions that would produce specified results	Yes	Already Introduced	Dual Credit Geology
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	No		

Identify strengths and weaknesses in one or more models	No		
Identify similarities and differences between models	Yes	Already Introduced	Dual Credit Geology
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Already Introduced	Dual Credit Geology

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	Yes	Already Introduced	Already Mastered
Determine the hypothesis for an experiment	Yes	Already Introduced	Already Mastered
Identify an alternate method for testing a hypothesis	No		

Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	Yes	Already Introduced	Dual Credit Geology

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	No		
Analyze given information when presented with new, complex information	Yes	Dual Credit Geology	Dual Credit Geology
Understand precision and accuracy issues	Yes	Dual Credit Geology	Dual Credit Geology
Predict how modifying the design or methods of an experiment will affect results	Yes	Dual Credit Geology	Dual Credit Geology
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		

Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 9

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Physical Science	Biology
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Physical Science	Physics

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Already Introduced	Physical Science
Understand basic scientific terminology	Yes	Already Introduced	Physical Science

Find basic information in a brief body of text	Yes	Already Introduced	Physical Science
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Physical Science	Physics
Understand the methods and tools used in a simple experiment	Yes	Physical Science	Geology

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Physical Science	Chemistry
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Physical Science	Physics
Translate information into a table, graph, or diagram	Yes	Physical Science	Physics
Understand the methods and tools used in a moderately complex experiment	No	Already Introduced	Already Mastered
Understand a simple experimental design	No	Already Introduced	Already Mastered
Identify a control in an experiment	No	Already Introduced	Already Mastered

Identify similarities and differences between experiments	No	Already Introduced	Already Mastered
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Already Introduced	Physical Science
Identify key issues or assumptions in a model	No		

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	No	Already Introduced	Already Mastered
Compare or combine data from a complex data presentation	No	Already Introduced	Already Mastered
Interpolate between data points in a table or graph	Yes	Physics	Not Mastered
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	Yes	Physical Science	Physics
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Physical Science	Physics
Analyze given information when presented with new, simple information	Yes	Physical Science	Physics

Understand the methods and tools used in a complex experiment	No		
Understand a complex experimental design	No		
Predict the results of an additional trial or measurement in an experiment	Yes	Physics	Not Mastered
Determine the experimental conditions that would produce specified results	Yes	Physics	Not Mastered
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Physics	Not Mastered
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Physics	Not Mastered
Identify strengths and weaknesses in one or more models	Yes	Geology	Not Mastered
Identify similarities and differences between models	No	Already Introduced	Already Mastered
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Physics	Not Mastered

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	Yes	Already Introduced	Physics
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	Yes	Physical Science	Physics
Extrapolate from data points in a table or graph	Yes	Physics	Not Mastered
Determine the hypothesis for an experiment	Yes	Already Introduced	Physics
Identify an alternate method for testing a hypothesis	No		
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	Yes	Physics	Not Mastered
Determine whether new information supports or weakens a model, and why	No		
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	Yes	Already Introduced	Physical Science
Analyze given information when presented with new, complex information	No		
Understand precision and accuracy issues	Yes	Already Introduced	Physical Science
Predict how modifying the design or methods of an experiment will affect results	Yes	Physical Science	Physics
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Yes	Physics	Not Mastered
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	No		

Respondent 10

Science College Readiness Standards for Score Range 13-15			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)	Yes	Physical Science	Physical Science
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)	Yes	Physical Science	Physical Science

Science College Readiness Standards for Score Range 16-19			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select two or more pieces of data from a simple data presentation	Yes	Physical Science	Physical Science
Understand basic scientific terminology	Yes	Physical Science	Physical Science
Find basic information in a brief body of text	Yes	Physical Science	Physical Science
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Physical Science	Physical Science

Understand the methods and tools used in a simple experiment	Yes	Physical Science	Biology

Science College Readiness Standards for Score Range 20-23			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	Biology	Anatomy and Physiology
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Physical Science	Biology
Translate information into a table, graph, or diagram	Yes	Physical Science	Physical Science
Understand the methods and tools used in a moderately complex experiment	Yes	Biology	Anatomy and Physiology
Understand a simple experimental design	Yes	Physical Science	Physical Science
Identify a control in an experiment	Yes	Biology	Biology
Identify similarities and differences between experiments	Yes	Physical Science	Physical Science
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	Biology	Biology

Identify key issues or assumptions in a model	Yes	Biology	Biology

Science College Readiness Standards for Score Range 24-27			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	Yes	Biology	Anatomy and Physiology
Compare or combine data from a complex data presentation	Yes	Anatomy and Physiology	Anatomy and Physiology
Interpolate between data points in a table or graph	Yes	Physical Science	Biology
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	No		
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Physical Science	Physical Science
Analyze given information when presented with new, simple information	Yes	Biology	Biology
Understand the methods and tools used in a complex experiment	Yes	Physical Science	Biology
Understand a complex experimental design	No		

Predict the results of an additional trial or measurement in an experiment	Yes	Physical Science	Physical Science
Determine the experimental conditions that would produce specified results	Yes	Physical Science	Physical Science
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Physical Science	Physical Science
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Anatomy and Physiology	Anatomy and Physiology
Identify strengths and weaknesses in one or more models	Yes	Anatomy and Physiology	Anatomy and Physiology
Identify similarities and differences between models	No		
Determine which model(s) is(are) supported or weakened by new information	No		
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Anatomy and Physiology	Anatomy and Physiology

Science College Readiness Standards for Score Range 28-32			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from a simple data presentation with data from a complex data presentation	No		

Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	No		
Extrapolate from data points in a table or graph	Yes	Physical Science	Physical Science
Determine the hypothesis for an experiment	Yes	Physical Science	Physical Science
Identify an alternate method for testing a hypothesis	No		
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	No		
Determine whether new information supports or weakens a model, and why	Yes	Biology	Biology
Use new information to make a prediction based on a model	No		

Science College Readiness Standards for Score Range 33-36			
	For each skill, knowledge, or process:		
Science Standards	Is it included in your science curriculum?	In which course are students first introduced to it?	In which course are students expected to demonstrate proficiency?
Compare or combine data from two or more complex data presentations	Yes	Anatomy and Physiology	Anatomy and Physiology
Analyze given information when presented with new, complex information	Yes	Anatomy and Physiology	Anatomy and Physiology

Understand precision and accuracy issues	Yes	Physical Science	Physical Science
Predict how modifying the design or methods of an experiment will affect results	Yes	Biology	Biology
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	No		
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	Anatomy and Physiology	Anatomy and Physiology
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	Yes	Anatomy and Physiology	Anatomy and Physiology

Note. Adapted from "Curriculum Review Worksheets," by ACT, Inc. 2006, pp. 20-25.

Appendix F: Raw Archival ACT Data

#	Gender	ACT English	ACT Mathematics	ACT Reading	ACT Science	ACT Composite Score
1	Male	22	21	28	24	24
2	Female	25	18	20	21	21
3	Female	22	17	18	20	19
4	Male	28	31	25	26	28
5	Male	24	25	22	20	23
6	Male	22	22	19	23	22
7	Female	16	22	23	24	21
8	Female	22	19	18	24	21
9	Male	21	20	19	25	21
10	Female	22	18	20	19	20
11	Male	23	23	14	20	20
12	Male	20	17	13	13	16
13	Female	16	20	15	17	17
14	Male	23	19	15	20	19
15	Female	19	19	22	20	20
16	Female	12	17	14	13	14
17	Male	20	25	22	19	22
18	Male	24	25	19	20	22
19	Female	19	21	24	22	22
20	Male	17	25	22	24	22
21	Female	25	25	29	26	26
22	Female	18	20	16	20	19
23	Female	12	22	16	20	18
24	Female	21	23	21	26	23
25	Male	25	24	24	27	25
26	Male	16	17	24	20	19
27	Male	22	25	21	21	22
28	Female	16	22	23	23	21
29	Female	22	23	19	22	22
30	Female	10	12	14	13	12
31	Male	15	18	17	20	18
32	Male	21	25	20	23	22
33	Female	18	18	21	20	19
34	Female	24	30	25	24	26
35	Female	19	23	19	23	21

36	Male	17	20	22	17	19
37	Female	22	18	18	22	20
38	Male	24	22	26	23	24
39	Female	21	17	20	14	18
40	Female	20	21	24	21	22
41	Female	30	25	31	23	27
42	Female	18	22	13	22	19
43	Male	16	17	21	18	18
44	Male	25	23	18	24	23
45	Female	21	16	24	19	20
46	Female	28	26	22	22	25
47	Female	25	19	33	20	24
48	Male	18	18	18	15	17
49	Male	20	22	23	25	23
50	Male	20	19	16	21	19
51	Female	26	19	31	23	25
52	Female	24	21	20	20	21
53	Male	25	26	28	24	26
54	Female	21	18	14	19	18
55	Female	26	32	28	24	28
56	Male	20	22	21	18	20
57	Male	15	20	14	20	17
58	Female	20	24	18	23	21
59	Male	13	18	23	17	18
60	Female	23	20	29	26	25
61	Female	24	23	20	21	22
62	Female	20	18	19	22	20
63	Male	26	28	30	32	29
64	Male	15	17	17	20	17
65	Female	25	23	26	23	24
66	Male	16	17	7	15	14
67	Male	21	24	22	24	23
68	Male	28	26	28	24	27
69	Female	21	16	21	20	20
70	Female	16	17	18	20	18
71	Female	10	15	7	10	11
72	Male	16	17	21	21	19
73	Male	17	17	22	20	19
74	Male	12	16	12	18	15

75	Female	18	16	14	22	18
76	Female	20	16	22	20	20
77	Male	23	20	25	23	23
78	Female	15	21	19	20	19
79	Female	25	22	26	27	25
80	Male	19	26	17	24	22
81	Female	13	15	20	20	17
82	Female	22	19	21	19	20
83	Female	16	17	20	21	19
84	Female	30	15	27	24	24
85	Female	26	17	29	22	24
86	Male	20	22	22	21	21
87	Female	23	22	23	21	22
88	Male	19	23	21	19	21
89	Female	20	19	20	22	20
90	Female	20	18	14	15	17
91	Female	21	22	17	20	20
92	Female	21	19	18	22	20
93	Female	34	33	34	26	32
94	Male	24	25	24	25	25
95	Female	21	16	17	18	18
96	Male	22	22	28	24	24
97	Male	18	18	22	19	19
98	Female	11	20	16	17	16
99	Female	21	17	22	21	20
100	Female	10	20	14	16	15
101	Male	36	24	34	29	31
102	Female	22	25	18	23	22
103	Male	22	26	21	25	24
104	Male	18	17	20	21	19
105	Male	16	19	14	17	17
106	Female	12	17	16	19	16
107	Male	21	23	31	25	25
108	Male	13	15	19	20	17
109	Male	28	32	24	26	28
110	Female	14	14	18	14	15
111	Male	27	25	24	30	27
112	Female	18	16	21	19	19
113	Male	25	28	24	25	26

114	Female	20	17	19	18	19
115	Female	14	15	17	13	15
116	Female	21	23	18	23	21
117	Female	19	24	19	20	21
118	Female	21	22	26	19	22
119	Female	33	27	31	28	30
120	Male	7	15	16	17	14
121	Male	20	15	24	21	20
122	Male	20	23	21	20	21
123	Female	22	17	30	19	22
124	Male	30	26	25	24	26
125	Female	21	15	16	18	18
126	Female	31	22	30	23	27
127	Female	27	27	28	25	27
128	Female	29	22	30	25	27
129	Female	23	26	26	22	24
130	Female	23	19	19	22	21
131	Female	14	15	17	17	16
132	Male	23	25	28	27	26
133	Male	26	22	22	22	23
134	Male	26	27	24	26	26
135	Male	35	28	34	29	32
136	Female	26	27	29	25	27
137	Female	24	22	22	21	22
138	Female	23	16	18	18	19
139	Female	15	16	19	20	18
140	Female	22	25	25	26	25
141	Male	14	16	14	12	14
142	Female	21	22	27	20	23
143	Male	22	24	21	21	22
144	Female	25	17	26	22	23
145	Female	14	14	14	10	13
146	Female	21	21	28	27	24
147	Male	14	15	19	21	17
148	Male	23	19	32	25	25
149	Female	21	24	24	26	24
150	Male	23	28	22	25	25
151	Male	14	15	15	18	16
152	Male	24	26	30	27	27

153	Male	20	19	20	21	20
154	Female	22	18	19	19	20
155	Male	20	22	17	19	20
156	Female	21	24	18	21	21
157	Male	15	16	19	17	17
158	Female	14	15	17	14	15
159	Female	14	15	16	16	15
160	Female	17	25	21	18	20
161	Male	23	17	32	20	23
162	Female	30	30	27	25	28
163	Male	24	18	20	21	21
164	Male	17	17	20	21	19
165	Male	20	16	16	21	18
166	Male	20	21	19	22	21
167	Male	28	26	33	29	29
168	Male	18	24	26	26	24
169	Male	12	19	21	19	18
170	Male	21	20	21	23	21
171	Female	26	17	26	19	22
172	Male	19	18	16	25	20
173	Female	21	16	20	21	20
174	Male	15	17	17	21	18
175	Female	20	16	19	18	18
176	Female	22	22	21	21	22
177	Female	32	27	31	31	30
178	Female	25	25	22	21	23
179	Male	33	34	32	30	32
180	Female	33	25	32	26	29
181	Male	16	18	14	15	16
182	Female	24	23	20	19	22
183	Female	10	15	17	18	15
184	Male	23	27	23	25	25
185	Female	33	18	30	25	27
186	Female	10	14	13	12	12
187	Female	25	24	22	19	23
188	Female	32	25	24	25	27
189	Female	14	22	16	20	18
190	Male	21	23	19	21	21
191	Female	14	12	16	13	14

192	Male	22	25	22	22	23
193	Male	10	13	12	15	13
194	Female	27	25	25	23	25
195	Male	21	20	30	21	23
196	Female	22	25	21	24	23
197	Female	18	14	16	20	17
198	Female	20	16	16	20	18
199	Male	25	16	31	23	24
200	Female	19	19	17	20	19
201	Female	23	21	26	24	24
202	Male	21	28	24	26	25
203	Male	21	18	16	24	20
204	Female	26	23	21	22	23
205	Female	25	22	25	25	24
206	Female	21	17	22	20	20
207	Female	16	18	18	17	17
208	Female	25	20	25	20	23
209	Female	35	18	35	24	28
210	Female	26	26	21	25	25
211	Female	20	16	22	18	19
212	Male	17	20	20	21	20
213	Female	16	15	15	18	16
214	Female	21	20	20	21	21
215	Female	22	19	22	19	21
216	Male	20	24	28	23	24
217	Male	16	20	20	24	20
218	Male	21	22	21	23	22
219	Female	14	18	15	21	17
220	Female	15	17	16	15	16
221	Male	25	24	35	28	28
222	Male	25	25	25	25	25
223	Female	12	16	15	20	16
224	Female	14	15	16	17	16
225	Male	14	12	19	16	15
226	Female	25	20	28	20	23
227	Male	8	15	11	19	13
228	Female	20	17	21	9	17
229	Female	25	23	27	23	25
230	Female	23	22	28	23	24

231	Male	8	15	13	13	12
232	Male	20	21	19	21	20
233	Male	19	14	25	17	19
234	Male	18	16	23	20	19
235	Male	23	16	27	18	21
236	Female	26	19	28	23	24
237	Male	21	26	25	26	25
238	Male	26	20	24	20	23
239	Female	26	18	20	20	21
240	Female	23	16	25	20	21
241	Female	16	16	18	21	18
242	Male	22	21	26	23	23
243	Male	25	20	22	20	22
244	Male	18	17	22	18	19
245	Female	22	24	20	25	23
246	Male	15	15	13	14	14
247	Female	24	19	24	24	23
248	Male	24	23	20	23	23
249	Male	23	19	28	17	22
250	Male	17	19	16	19	18
251	Female	23	25	26	28	26
252	Female	16	16	17	14	16
253	Male	17	20	15	21	18
254	Male	16	21	16	23	19
255	Male	30	32	30	30	31
256	Female	18	23	21	24	22
257	Male	22	23	24	21	23
258	Male	11	14	12	16	13
259	Female	22	24	20	19	21
260	Female	14	19	18	16	17
261	Male	23	26	27	25	25
262	Female	31	27	35	23	29
263	Male	19	18	23	22	21
264	Female	21	20	15	15	18
265	Female	28	18	28	23	24
266	Female	17	19	18	21	19
267	Male	20	18	20	20	20
268	Male	20	20	23	21	21
269	Female	14	16	15	12	14

270	Female	16	19	18	18	18
271	Male	19	18	24	21	21
272	Female	17	17	16	18	17
273	Male	19	20	26	27	23
274	Male	22	27	19	24	23
275	Female	20	19	20	23	21
276	Female	23	22	21	23	22
277	Female	23	17	22	20	21
278	Female	20	18	22	22	21
279	Female	18	15	16	18	17
280	Male	20	16	21	21	20
281	Female	21	25	24	22	23
282	Female	24	26	25	22	24
283	Male	15	17	15	18	16
284	Female	21	15	30	20	22
285	Male	17	24	17	17	19
286	Female	24	21	26	24	24
287	Female	22	23	19	19	21
288	Male	12	15	20	19	17
289	Male	6	15	14	14	12
290	Female	24	23	23	21	23
291	Female	32	34	29	30	31
292	Male	20	17	20	19	19
293	Female	14	14	17	17	16
294	Male	21	17	22	20	20
295	Female	13	15	14	15	14
296	Female	20	19	22	24	21
297	Female	21	17	24	20	21
298	Female	34	25	30	24	28
299	Female	20	17	24	20	20
300	Female	25	17	30	21	23
301	Female	29	27	30	27	28
302	Female	11	16	14	15	14
303	Male	24	23	19	20	22
304	Male	33	23	33	27	29
305	Male	27	24	32	27	28
306	Male	23	22	23	24	23
307	Female	23	17	23	19	21
308	Male	15	15	14	17	15

309	Male	11	20	13	18	16
310	Female	19	16	16	18	17
311	Male	18	19	22	21	20
312	Female	25	23	24	17	22
313	Female	25	26	28	25	26
314	Female	20	24	24	22	23
315	Male	30	31	35	31	32
316	Male	21	24	22	23	23
317	Male	26	26	30	30	28
318	Female	24	25	21	21	23
319	Male	20	15	22	22	20
320	Male	25	34	29	28	29
321	Male	16	18	20	23	19
322	Male	20	24	22	24	23
323	Male	22	25	22	23	23
324	Female	32	26	22	26	27
325	Male	21	12	28	22	21
326	Male	22	23	24	21	23
327	Male	17	18	21	22	20
328	Male	31	34	29	32	32
329	Female	24	19	23	23	22
330	Female	24	17	21	23	21
331	Male	20	19	19	27	21
332	Male	20	23	23	24	23
333	Female	24	21	25	29	25
334	Female	19	19	23	21	21
335	Female	15	18	18	19	18
336	Female	21	17	19	19	19
337	Female	25	23	27	22	24
338	Female	22	27	23	22	24
339	Female	22	22	18	24	22
340	Female	21	17	15	18	18
341	Female	20	23	25	19	22
342	Male	27	27	29	24	27
343	Female	26	26	24	24	25
344	Male	16	16	33	23	22
345	Female	23	16	20	20	20
346	Male	15	16	16	15	16
347	Female	16	17	18	19	18

348	Female	9	14	11	10	11
349	Female	35	23	30	21	27
350	Female	14	17	18	15	16
351	Female	21	19	24	20	21
352	Male	18	20	20	21	20
353	Male	22	24	22	26	24
354	Female	12	17	10	16	14
355	Male	23	24	26	32	26
356	Female	20	18	21	19	20
357	Male	16	22	23	19	20
358	Male	19	21	18	18	19
359	Female	23	16	27	19	21
360	Female	15	20	19	19	18
361	Male	18	17	23	21	20
362	Male	22	24	29	25	25
363	Female	19	21	24	23	22
364	Female	24	23	21	18	22
365	Female	21	22	21	21	21
366	Female	22	20	22	19	21
367	Male	19	17	14	24	19
368	Male	18	19	21	23	20
369	Male	16	26	19	22	21
370	Male	25	29	24	26	26
371	Male	23	25	28	25	25
372	Male	18	23	24	21	22
373	Male	20	18	23	24	21
374	Female	20	17	20	21	20
375	Female	16	16	19	20	18
376	Male	23	16	27	21	22
377	Female	19	15	20	20	19
378	Male	19	29	27	21	24
379	Female	17	26	16	19	20
380	Male	28	29	27	25	27
381	Female	14	15	16	18	16
382	Female	21	23	29	20	23
383	Female	23	17	23	20	21
384	Male	18	24	25	23	23
385	Female	19	17	23	20	20
386	Female	36	32	32	29	32

387	Female	12	16	15	12	14
388	Female	20	21	19	20	20
389	Female	22	24	18	23	22
390	Female	22	21	25	24	23
391	Female	24	28	17	21	23
392	Male	15	15	16	23	17
393	Male	14	18	12	21	16
394	Male	27	28	27	28	28
395	Female	23	17	21	20	20
396	Male	29	26	31	29	29
397	Male	22	22	18	19	20
398	Male	19	25	24	20	22
399	Male	5	13	13	10	10
400	Male	23	20	18	20	20
401	Male	13	17	16	8	14
402	Female	27	24	36	28	29
403	Male	17	15	18	10	15
404	Male	21	25	21	24	23
405	Male	18	17	16	22	18
406	Female	22	21	24	22	22
407	Female	20	17	14	21	18
408	Male	22	22	23	23	23
409	Male	22	21	16	21	20
410	Female	10	14	14	17	14
411	Female	19	13	25	19	19
412	Female	24	23	23	20	23
413	Female	14	17	18	20	17
414	Female	14	16	13	18	15
415	Male	24	27	30	30	28
416	Female	19	18	23	21	20
417	Male	20	25	14	21	20
418	Male	23	25	29	31	27
419	Female	19	24	17	25	21
420	Male	26	32	30	35	31
421	Female	31	28	30	30	30
422	Male	17	16	19	21	18
423	Male	11	14	15	12	13
424	Male	19	21	24	24	22
425	Male	23	22	23	22	23

426	Female	26	24	29	26	26
427	Female	13	17	17	16	16
428	Female	18	17	21	23	20
429	Female	25	16	25	22	22
430	Female	18	16	22	21	19
431	Female	23	26	25	21	24
432	Female	21	22	19	20	21
433	Female	20	21	19	22	21
434	Male	28	29	35	30	31
435	Female	14	16	18	18	17
436	Male	11	16	13	18	15
437	Female	16	19	14	18	17
438	Male	16	25	22	23	22
439	Female	15	14	18	17	16
440	Female	18	21	19	20	20
441	Male	23	22	33	27	26
442	Female	22	25	29	23	25
443	Female	21	25	21	22	22
444	Male	22	20	29	23	24
445	Female	21	27	25	26	25
446	Female	8	16	8	13	12
447	Male	22	25	26	25	25
448	Male	16	15	19	17	17
449	Male	33	25	27	25	28
450	Female	15	15	14	15	15
451	Male	16	15	15	14	15
452	Female	23	23	31	31	27
453	Female	24	24	29	22	25
454	Male	20	25	18	23	22
455	Male	12	20	15	18	16
456	Male	20	18	14	22	19
457	Female	22	17	20	20	20
458	Female	19	16	21	22	20
459	Male	30	29	32	35	32
460	Male	16	24	17	23	20
461	Male	22	27	21	28	25
462	Male	23	26	21	24	24
463	Male	32	35	34	27	32
464	Male	17	16	20	21	19

465	Male	22	21	19	21	21
466	Male	24	23	24	26	24
467	Male	18	16	23	20	19
468	Male	28	26	32	33	30
469	Male	18	15	17	20	18

Appendix G: Letter from P. R. Brandon to Use Inquiry Science Implementation Scale

Cathy - Thanks for your interest in the questionnaire. Yes, you may of course use the it for your study. I hope it is helpful!

Paul

Paul R. Brandon, PhD
Professor of Education
Editor-in-Chief, *New Directions for Evaluation*
Exemplars Section Co-Editor, *American Journal of Evaluation*
Curriculum Research & Development Group
Graduate faculty member, Educational Psychology
College of Education
University of Hawai'i at Mānoa
[redacted]

On Sat, Mar 16, 2013 at 9:39 AM, Cathy Robertson <[redacted]> wrote:

Aloha Dr. Brandon,

My name is Cathy Robertson and I am a doctoral student with Walden University. The topic of the project study through the university is a program evaluation of the science department where I work, a low-income high school in rural Missouri. The dynamics of my project have changed directions from where I originally thought they were going to take me. Reading "The inquiry science implementation scale: Development and applications" peaked my interest in your groups ISIS scale. I would like to formally ask if I may reproduce and use your scale in my doctoral study. I would like to use the 22 questions, but as suggested at the end of your research, I may need to use a wider ranged scale. My entire science department consists of six teachers, including myself, so this is not a large-scale study by any means. I greatly appreciate your time.

Thank you,

Cathy Robertson
[redacted]

Appendix H: Inquiry Science Implementation Scale

Question	Almost Never ≤15%	Seldom 16-29%	Sometimes 30-49%	Often 50-74%	Almost Always ≥75%
1. Demonstrate the use of a new instrument?					
2. Have students write the problem or activity before doing an experiment?					
3. Review relevant concepts and skills that were learned in previous lessons?					
4. Introduce new vocabulary words?					
5. Ask students to identify and define words?					
6. Ask students to make predictions about an experiment?					
7. Check to ensure that students understand new procedures before beginning an experiment?					
8. Discuss how everyday situations directly relate to experiments that students are currently or will be conducting?					
9. Check students' designs for safety before allowing them to conduct their experiments?					
10. Monitor small group progress during experiments?					

11. Encourage students to collaborate within their groups?					
12. Circulate and interact with students while they are conducting experiments?					
13. Discuss variations in data collected by students following their experiments?					
14. Have students share their predictions with the class?					
15. Have students share their data or findings with the class?					
16. Challenge students to consider the effects of errors on groups' results?					
17. Compare and contrast students' explanations of findings?					
18. Question students as they conduct their experiments?					
19. Connect new information with students' personal lives (interests, home environment, community, culture, etc.)?					
20. Connect current events and other subjects with current science concepts, skills, and investigations?					

21. Use questioning strategies to respond to students' questions about experiments?					
22. Have students ask questions about the scientific phenomena addressed during experiments?					

Note. Adapted from "The inquiry science implementation scale: development and applications," by P. R. Brandon, D. B. Young, F. M. Pottenger, and A. K. Taum, 2009, International Journal of Science and Mathematics Education, 7, p. 1140. Copyright 2009 by the National Science Council.

Appendix I: Inquiry Science Implementation Scale: Raw Data

	Response Number									
Question	#1	#2	#3	#4	#5	#6	#7	#8	#9	Average
1. Demonstrate the use of a new instrument?	4	2	3	3	2	2	2	3	4	2.8
2. Have students write the problem or activity before doing an experiment?	4	4	3	2	2	2	4	5	3	3.2
3. Review relevant concepts and skills that were learned in previous lessons?	4	4	5	5	5	3	5	3	4	4.2
4. Introduce new vocabulary words?	4	4	5	5	5	5	5	3	5	4.6
5. Ask students to identify and define words?	3	2	5	5	3	5	5	2	5	3.9
6. Ask students to make predictions about an experiment?	3	3	3	4	3	3	4	5	3	3.4
7. Check to ensure that students understand new procedures before beginning an experiment?	4	5	2	4	5	3	3	2	5	3.7
8. Discuss how everyday situations directly relate to experiments that students are currently or will be conducting?	4	3	5	5	5	3	3	2	5	3.9

9. Check students' designs for safety before allowing them to conduct their experiments?	4	5	5	2	2	3	3	3	5	3.6
10. Monitor small group progress during experiments?	5	4	5	5	5	3	5	5	5	4.7
11. Encourage students to collaborate within their groups?	4	5	4	4	5	3	5	3	5	4.2
12. Circulate and interact with students while they are conducting experiments?	5	5	5	5	5	4	5	4	5	4.8
13. Discuss variations in data collected by students following their experiments?	4	4	2	4	3	3	3	1	3	3.0
14. Have students share their predictions with the class?	5	3	1	1	2	4	3	1	2	2.4
15. Have students share their data or findings with the class?	5	4	1	2	2	4	3	1	2	2.7
16. Challenge students to consider the effects of errors on groups' results?	3	2	4	2	2	2	3	5	2	2.8
17. Compare and contrast students' explanations of findings?	3	3	2	2	2	3	3	1	3	2.4

18. Question students as they conduct their experiments?	5	4	5	5	5	3	5	3	3	4.2
19. Connect new information with students' personal lives (interests, home environment, community, culture, etc.)?	5	2	5	5	5	3	4	3	5	4.1
20. Connect current events and other subjects with current science concepts, skills, and investigations?	5	3	4	5	5	3	3	3	3	3.8
21. Use questioning strategies to respond to students' questions about experiments?	5	3	3	5	5	3	5	3	3	3.9
22. Have students ask questions about the scientific phenomena addressed during experiments?	4	3	1	4	5	2	4	2	3	3.1
Total Average	**4.2**	**3.5**	**3.5**	**3.8**	**3.8**	**3.1**	**3.9**	**2.9**	**3.8**	**3.6**

Note. Adapted from "The inquiry science implementation scale: development and applications," by P. R. Brandon, D. B. Young, F. M. Pottenger, and A. K. Taum, 2009, International Journal of Science and Mathematics Education, 7, p. 1140. Copyright 2009 by the National Science Council.
Teachers had the ability to fill the form out more than once for different courses.
(1) Almost Never, ≤15%; (2) Seldom, 16-29%; (3) Sometimes, 30-49%; (4) Often, 50-74%; and (5) Almost Always, ≥.

Appendix J: License Agreement From John Wiley and Sons to Use Interview Questions

for Participants

JOHN WILEY AND SONS LICENSE TERMS AND CONDITIONS

Sep 24, 2013

This is a License Agreement between Cathy Robertson ("You") and John Wiley and Sons ("John Wiley and Sons") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by John Wiley and Sons, and the payment terms and conditions.

All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.

License Number	3235411143831
License date	Sep 24, 2013
Licensed content publisher	John Wiley and Sons
Licensed content publication	School Science and Mathematics
Licensed content title	Voices from the Front Lines: Exemplary Science Teachers on Education Reform
Licensed copyright line	© 2012, School Science and Mathematics Association
Licensed content author	Erin Peters Burton, Wendy Michelle Frazier
Licensed content date	Mar 1, 2012
Start page	179
End page	190
Type of use	Dissertation/Thesis
Requestor type	University/Academic
Format	Print
Portion	Text extract
Number of Pages	1

Will you be translating?	No
Total	0.00 USD

Terms and Conditions

TERMS AND CONDITIONS

This copyrighted material is owned by or exclusively licensed to John Wiley & Sons, Inc. or one of its group companies (each a "Wiley Company") or a society for whom a Wiley Company has exclusive publishing rights in relation to a particular journal (collectively "WILEY"). By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the billing and payment terms and conditions established by the Copyright Clearance Center Inc., ("CCC's Billing and Payment terms and conditions"), at the time that you opened your RightsLink account (these are available at any time at http://myaccount.copyright.com).

Terms and Conditions

1. The materials you have requested permission to reproduce (the "Materials") are protected by copyright.

2.You are hereby granted a personal, non-exclusive, non-sublicensable, non-transferable, worldwide, limited license to reproduce the Materials for the purpose specified in the licensing process. This license is for a one-time use only with a maximum distribution equal to the number that you identified in the licensing process. Any form of republication granted by this license must be completed within two years of the date of the grant of this license (although copies prepared before may be distributed thereafter). The Materials shall not be used in any other manner or for any other purpose. Permission is granted subject to an appropriate acknowledgement given to the author, title of the material/book/journal and the publisher. You shall also duplicate the copyright notice that appears in the Wiley publication in your use of the Material. Permission is also granted on the understanding that nowhere in the text is a previously published source acknowledged for all or part of this Material. Any third party material is expressly excluded from this permission.

3. With respect to the Materials, all rights are reserved. Except as expressly granted by the terms of the license, no part of the Materials may be copied, modified, adapted (except for minor reformatting required by the new Publication), translated, reproduced, transferred or distributed, in any form or by any means, and no derivative works may be made based on the Materials without the prior permission of the respective copyright owner. You may not alter, remove or suppress in any manner any copyright, trademark or other notices displayed by the Materials. You may not license, rent, sell, loan, lease, pledge, offer as security, transfer or assign the Materials, or any of the rights granted to you hereunder to any other

person.

4. The Materials and all of the intellectual property rights therein shall at all times remain the exclusive property of John Wiley & Sons Inc. or one of its related companies (WILEY) or their respective licensors, and your interest therein is only that of having possession of and the right to reproduce the Materials pursuant to Section 2 herein during the continuance of this Agreement. You agree that you own no right, title or interest in or to the Materials or any of the intellectual property rights therein. You shall have no rights hereunder other than the license as provided for above in Section 2. No right, license or interest to any trademark, trade name, service mark or other branding ("Marks") of WILEY or its licensors is granted hereunder, and you agree that you shall not assert any such right, license or interest with respect thereto.

5. NEITHER WILEY NOR ITS LICENSORS MAKES ANY WARRANTY OR REPRESENTATION OF ANY KIND TO YOU OR ANY THIRD PARTY, EXPRESS, IMPLIED OR STATUTORY, WITH RESPECT TO THE MATERIALS OR THE ACCURACY OF ANY INFORMATION CONTAINED IN THE MATERIALS, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY, ACCURACY, SATISFACTORY QUALITY, FITNESS FOR A PARTICULAR PURPOSE, USABILITY, INTEGRATION OR NON-INFRINGEMENT AND ALL SUCH WARRANTIES ARE HEREBY EXCLUDED BY WILEY AND ITS LICENSORS AND WAIVED BY YOU.

6. WILEY shall have the right to terminate this Agreement immediately upon breach of this Agreement by you.

7. You shall indemnify, defend and hold harmless WILEY, its Licensors and their respective directors, officers, agents and employees, from and against any actual or threatened claims, demands, causes of action or proceedings arising from any breach of this Agreement by you.

8. IN NO EVENT SHALL WILEY OR ITS LICENSORS BE LIABLE TO YOU OR ANY OTHER PARTY OR ANY OTHER PERSON OR ENTITY FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY OR PUNITIVE DAMAGES, HOWEVER CAUSED, ARISING OUT OF OR IN CONNECTION WITH THE DOWNLOADING, PROVISIONING, VIEWING OR USE OF THE MATERIALS REGARDLESS OF THE FORM OF ACTION, WHETHER FOR BREACH OF CONTRACT, BREACH OF WARRANTY, TORT, NEGLIGENCE, INFRINGEMENT OR OTHERWISE (INCLUDING, WITHOUT LIMITATION, DAMAGES BASED ON LOSS OF PROFITS, DATA, FILES, USE, BUSINESS OPPORTUNITY OR CLAIMS OF THIRD PARTIES), AND WHETHER OR NOT THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED

REMEDY PROVIDED HEREIN.

9. Should any provision of this Agreement be held by a court of competent jurisdiction to be illegal, invalid, or unenforceable, that provision shall be deemed amended to achieve as nearly as possible the same economic effect as the original provision, and the legality, validity and enforceability of the remaining provisions of this Agreement shall not be affected or impaired thereby.

10. The failure of either party to enforce any term or condition of this Agreement shall not constitute a waiver of either party's right to enforce each and every term and condition of this Agreement. No breach under this agreement shall be deemed waived or excused by either party unless such waiver or consent is in writing signed by the party granting such waiver or consent. The waiver by or consent of a party to a breach of any provision of this Agreement shall not operate or be construed as a waiver of or consent to any other or subsequent breach by such other party.

11. This Agreement may not be assigned (including by operation of law or otherwise) by you without WILEY's prior written consent.

12. Any fee required for this permission shall be non-refundable after thirty (30) days from receipt

13. These terms and conditions together with CCC's Billing and Payment terms and conditions (which are incorporated herein) form the entire agreement between you and WILEY concerning this licensing transaction and (in the absence of fraud) supersedes all prior agreements and representations of the parties, oral or written. This Agreement may not be amended except in writing signed by both parties. This Agreement shall be binding upon and inure to the benefit of the parties' successors, legal representatives, and authorized assigns.

14. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall prevail.

15. WILEY expressly reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

16. This Agreement will be void if the Type of Use, Format, Circulation, or Requestor Type was misrepresented during the licensing process.

17. This Agreement shall be governed by and construed in accordance with the laws of the State of New York, USA, without regards to such state's conflict of law rules. Any legal

action, suit or proceeding arising out of or relating to these Terms and Conditions or the breach thereof shall be instituted in a court of competent jurisdiction in New York County in the State of New York in the United States of America and each party hereby consents and submits to the personal jurisdiction of such court, waives any objection to venue in such court and consents to service of process by registered or certified mail, return receipt requested, at the last known address of such party.

Wiley Open Access Terms and Conditions

Wiley publishes Open Access articles in both its Wiley Open Access Journals program [http://www.wileyopenaccess.com/view/index.html] and as Online Open articles in its subscription journals. The majority of Wiley Open Access Journals have adopted the Creative Commons Attribution License (CC BY) which permits the unrestricted use, distribution, reproduction, adaptation and commercial exploitation of the article in any medium. No permission is required to use the article in this way provided that the article is properly cited and other license terms are observed. A small number of Wiley Open Access journals have retained the Creative Commons Attribution Non Commercial License (CC BY-NC), which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

Online Open articles - Authors selecting Online Open are, unless particular exceptions apply, offered a choice of Creative Commons licenses. They may therefore select from the CC BY, the CC BY-NC and the Attribution-NoDerivatives (CC BY-NC-ND). The CC BY-NC-ND is more restrictive than the CC BY-NC as it does not permit adaptations or modifications without rights holder consent.

Wiley Open Access articles are protected by copyright and are posted to repositories and websites in accordance with the terms of the applicable Creative Commons license referenced on the article. At the time of deposit, Wiley Open Access articles include all changes made during peer review, copyediting, and publishing. Repositories and websites that host the article are responsible for incorporating any publisher-supplied amendments or retractions issued subsequently.
Wiley Open Access articles are also available without charge on Wiley's publishing platform, **Wiley Online Library** or any successor sites.

Conditions applicable to all Wiley Open Access articles:

- The authors' moral rights must not be compromised. These rights include the right of "paternity" (also known as "attribution" - the right for the author to be identified as such) and "integrity" (the right for the author not to have the work altered in such a way that the author's reputation or integrity may be damaged).

- Where content in the article is identified as belonging to a third party, it is the obligation of the user to ensure that any reuse complies with the copyright policies of the owner of that content.

- If article content is copied, downloaded or otherwise reused for research and other purposes as permitted, a link to the appropriate bibliographic citation (authors, journal, article title, volume, issue, page numbers, DOI and the link to the definitive published version on Wiley Online Library) should be maintained. Copyright notices and disclaimers must not be deleted.
    - Creative Commons licenses are copyright licenses and do not confer any other rights, including but not limited to trademark or patent rights.

- Any translations, for which a prior translation agreement with Wiley has not been agreed, must prominently display the statement: "This is an unofficial translation of an article that appeared in a Wiley publication. The publisher has not endorsed this translation."

Conditions applicable to non-commercial licenses (CC BY-NC and CC BY-NC-ND)

For non-commercial and non-promotional purposes individual non-commercial users may access, download, copy, display and redistribute to colleagues Wiley Open Access articles. In addition, articles adopting the CC BY-NC may be adapted, translated, and text- and data-mined subject to the conditions above.

Use by commercial "for-profit" organizations

Use of non-commercial Wiley Open Access articles for commercial, promotional, or marketing purposes requires further explicit permission from Wiley and will be subject to a fee. Commercial purposes include:

- Copying or downloading of articles, or linking to such articles for further redistribution, sale or licensing;

- Copying, downloading or posting by a site or service that incorporates advertising with such content;

- The inclusion or incorporation of article content in other works or services (other than normal quotations with an appropriate citation) that is then available for sale or licensing, for a fee (for example, a compilation produced for marketing purposes, inclusion in a sales pack)

- Use of article content (other than normal quotations with appropriate citation) by for-profit organizations for promotional purposes

- Linking to article content in e-mails redistributed for promotional, marketing or educational purposes;
- Use for the purposes of monetary reward by means of sale, resale, license, loan, transfer or other form of commercial exploitation such as marketing products
- Print reprints of Wiley Open Access articles can be purchased from: corporatesales@wiley.com

The modification or adaptation for any purpose of an article referencing the CC BY-NC-ND License requires consent which can be requested from RightsLink@wiley.com .

Other Terms and Conditions:

BY CLICKING ON THE "I AGREE..." BOX, YOU ACKNOWLEDGE THAT YOU HAVE READ AND FULLY UNDERSTAND EACH OF THE SECTIONS OF AND PROVISIONS SET FORTH IN THIS AGREEMENT AND THAT YOU ARE IN AGREEMENT WITH AND ARE WILLING TO ACCEPT ALL OF YOUR OBLIGATIONS AS SET FORTH IN THIS AGREEMENT.

v1.8

If you would like to pay for this license now, please remit this license along with your payment made payable to "COPYRIGHT CLEARANCE CENTER" otherwise you will be invoiced within 48 hours of the license date. Payment should be in the form of a check or money order referencing your account number and this invoice number RLNK501120080.
Once you receive your invoice for this order, you may pay your invoice by credit card. Please follow instructions provided at that time.

Make Payment To:
Copyright Clearance Center
Dept 001
P.O. Box 843006
Boston, MA 02284-3006

Appendix K: Interview Questions for Participants

Inquiry

1. What is open-ended inquiry? Define, explain, and/or provide examples.
2. Do you think open-ended inquiry helps students learn science more effectively?
3. What do teachers need to know to conduct open-ended inquiry?
4. What do students need to know to conduct open-ended inquiry?
5. How might we get the science teachers in the high school to implement open-ended inquiry lessons?

Science Department issues

6. What do you think is the largest current problem in the science department?
7. Why do you think it is a problem?
8. What solutions might you offer to help solve this problem?
9. How might this problem be avoided in the future?

Note. Adapted from "Voices from the front lines: Exemplary science teachers on education reform," by E. P. Burton and W. M. Frazier, 2012, School Science and Mathematics, 112(3), pp. 179-190. Copyright 2012 by John Wiley & Sons Publications.

Appendix L: Interview Questions for Participants—Raw Data

Q1: What is open-ended inquiry? Define, explain, and/or provide examples.

Theme: active student learning

Respondent 1: Open-ended inquiry is not structured by the teacher. It allows students to use problem solving and exploration to come up with individualized answers. Science projects and individualized experiments are examples which use open-ended inquiry.

Respondent 2: Open-ended inquiry essentially depends upon continuous engagement of individuals with a process whose outcome is not predetermined. In this process, people gain the ability to acquire, evaluate, and find ways to make sense of information.

Respondent 3: When a person will research or look up things on their own to get a better understanding of a concept.

Respondent 4: An open-ended question is designed to encourage a full, meaningful answer using the subject's own knowledge and/or feelings. It is the opposite of a closed-ended question, which encourages a short or single-word answer. Is it safe to allow Ameren to bury their coal ash in a flood plain?

Respondent 5: Where the students come up with the questions that they want to answer or investigate.

Respondent 6: Students use prior knowledge to actively engage in new problem solving skills where they come up with their own answers. Open-ended inquiry is teacher facilitated, not led.

Respondent 7: Open ended has no one answer. As long as the answer relates to the question and is justified or supportive by the information it should receive partial to all credit.

Respondent 8: Open-ended inquiry in science is allowing students to research questions that they would be interested in.

Q2: Do you think open-ended inquiry helps students learn science more effectively?

Theme: application of skills

Respondent 1: Yes because it is student driven. It allows them to use their reasoning skills and problem solving.

Respondent 2: Yes, it must be the core of true experimentation.

Respondent 3: Yes.

Respondent 4: Yes.

Respondent 5: In some situations, but they do need a guided, structured learning environment some of the time.

Respondent 6: Yes. Students learn by applying their knowledge.

Respondent 7: Yes, It lets students know that there is more than one answer to certain questions.

Respondent 8: If the students use the scientific method to perform an experiment they can learn how to correctly come up with hypotheses and conclusions.

Q3: What do teachers need to know to conduct open-ended inquiry?

Theme: structured lesson that appears unstructured

Respondent 1: They need to know how to set up guidelines which allow students to be creative yet confine them to the curriculum.

Respondent 2: How to ask deliberate, leading (without telling) questions....and more importantly, how to show others the way to ask these type of questions.

Respondent 3: They need to know that others will have an interest while others might do nothing. I think that their needs to be a hands-on approach to the inquiry and have the proper equipment for it.

Respondent 4: What the end result needs to be.

Respondent 5: How to lead kids into asking the right questions without them knowing that you are guiding them.

Respondent 6: Teachers need to know how to facilitate in an environment where each student is producing their own outcomes, yet still be able to confine the topic to the delivered curriculum...difficult to achieve.

Respondent 7: Many answers.

Respondent 8: Teachers need to learn how to question students to get them excited and thinking. Teachers need to teach the students how to properly design and conduct research.

Q4: What do students need to know to conduct open-ended inquiry?

Theme: student application

Respondent 1: They need to know the expectations and guidelines.

Respondent 2: How to ask questions that will cause investigation....even if the questions lead "off track" for a time.

Respondent 3: They need to know that they are in charge of their learning and they have to get over the spoon-fed approach.

Respondent 4: Prior knowledge, background information, how to locate information and analyze it, the ability to see all sides of an issue.

Respondent 5: What to ask questions about and how to ask them, also to be able to find the answers they need.

Respondent 6: How to apply prior knowledge in new situations...cannot do unless they have been instructed in the proper techniques.

Respondent 7: To answer all parts of the questions.

Respondent 8: Students need to learn how to research problems and how to conduct experiments. They also need to learn how to record data and present information.

Q5: How might we get the science teachers in the high school to implement open-ended inquiry lessons?

Theme: time

Respondent 1: Allow for more time to be directed towards projects and experiments which utilize these types of lessons.

Respondent 2: Have small groups meet to develop these types of lessons. Make the lessons concise, and fun.

Respondent 3: Unlimited budget for the materials, a deep understanding of the material and the technology to help the students. I also think 15-18 students max per class.

Respondent 4: Science fair projects.

Respondent 5: We need more time to spend on the subjects instead of needing to teach to the test.

Respondent 6: 1) training in open-ended inquiry 2) time in the curriculum to go in depth on topics 3) collaboration time between teachers of the same subject to produce inquiry units.

Respondent 7: More hands on materials.

Respondent 8: I think teachers need to get out of their comfort zone and let students explore. It is hard for teachers to let go because of state and federal requirements.

Q6: What do you think is the largest current problem in the science department?

Theme: time and money

Respondent 1: Lack of collaboration time.

Respondent 2: All teachers are just TOO busy. Lack of quality time makes it difficult to really unify.

Respondent 3: Funding and equipment.

Respondent 4: Central Office administration wasting time and money.

Respondent 5: Funding.

Respondent 6: No collaboration time.

Respondent 7: The need for new/current textbooks.

Respondent 8: Lack of funding and support for growth.

Q7: Why do you think it is a problem?

Theme: collective external hindrance

Respondent 1: Teachers have more demands upon them to raise test scores and work on data collection which is time consuming.

Respondent 2: We don't meet all that often, and when we do, it's a rush. But I think all the department teachers are doing just fine....I'm happy.

Respondent 3: Science has outdated materials and technology that we have to use. Since this is a department with 11 different courses offered we have 11 different needs and wants and a limited budget to supply all needs. We have text books with materials that are 20 years old. Leading to outdated labs for students which does not prepare them for situations when they take science classes in college, they are already behind basic knowledge.

Respondent 4: Central Office administration doesn't ask what we need.

Respondent 5: We need to be able to have the resources to do certain labs and show certain examples so the students can actually see real-life examples.

Respondent 6: Teachers of the same subject do not know what is happening in other teachers' classes. We do not know what is already being covered in lower classes so many topics are being repeated or skipped over all together.

Respondent 7: Money.

Respondent 8: Because of state accreditation, more emphasis is put into math and English. Science and social studies are secondary in growth.

Q8: What solutions might you offer to help solve this problem?

Theme: collective internal solutions

Respondent 1: I would allow more time for collaboration, possibly during Professional Development days/times.

Respondent 2: None that haven't been tried.....we've had same plan periods and lunches in the past. I think we are actually doing fine as a department.

Respondent 3: I have been using my funds to supplement lab materials. Sharing the funds with others; one year biology gets what they need then the next a class I need, then the follow what another class needs.

Respondent 4: Central Office Administration taking classes on communication.

Respondent 5: I'm not sure.

Respondent 6: Use entire professional development days for vertical teaming and not just a random hour here and there.

Respondent 7: Getting textbooks on line for the Chromebooks.

Respondent 8: Try to show that science is cross curricular. Science shows how math is practical to the everyday world.

Q9: How might this problem be avoided in the future?

Theme: impending opportunities?

Respondent 1: I don't feel there is a way to avoid the problem. There are more demands being placed upon teachers every day. New technology may be able to assist with time constraints in regards to connectivity and collaboration.

Respondent 2: Maybe could set up a weekly touch base meeting....morning time (that could be hard for moms though)....Maybe on Wednesdays....just to touch base (if time left from regular staff meeting....)

Respondent 3: A bond issue passing.

Respondent 4: Central Office Administration asking us what we need.

Respondent 5: Allocate more funds towards the sciences.

Respondent 6: Principals and Superintendents need to listen to the needs of the teachers and actually follow through.

Respondent 7: This should not be an issue if book is online.

Respondent 8: Offer cross-curricular activities between English, Math, and Science.

Appendix M: Figures and SPSS Output Data for Quantitative Data

Figures for ACT Data

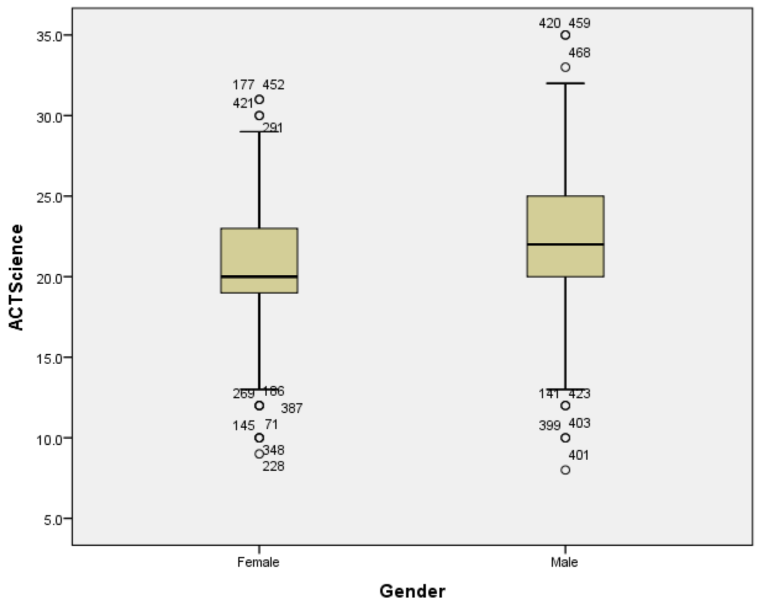


Figure M1. Stem and leaf plot showing science ACT scores by gender.

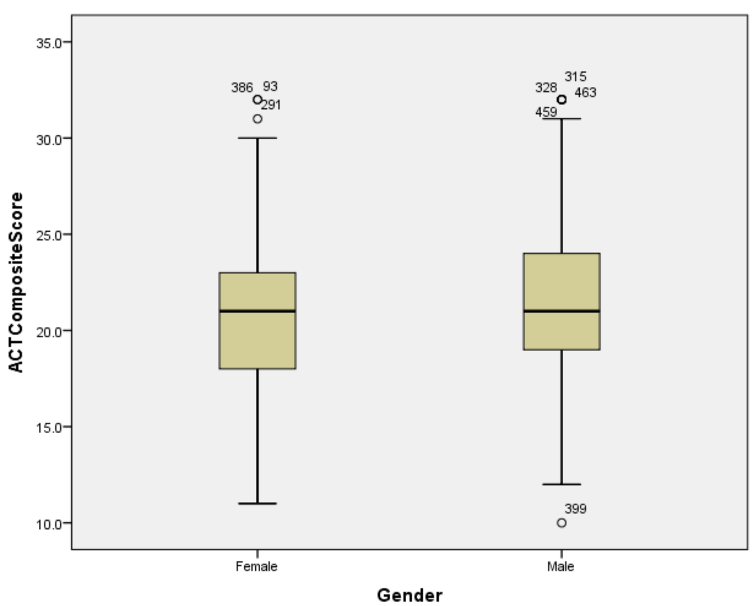


Figure M2. Stem and leaf plot showing composite ACT scores by gender.

SPSS Output for ACT Data

Table M1

One-Sample t-test for Science and Composite ACT Scores

	Test Value = 23					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
ACTScience	-8.690	468	.000	-1.6631	-2.039	-1.287
ACTCompositeScore	-9.116	468	.000	-1.7740	-2.156	-1.392

Note. N=469. The test value is the science college readiness standard of 23.

SPSS Output for ISIS Data

Table M2

Descriptive Statistics for ISIS Scores

	Min	Max	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Question1	2.00	4.00	2.7778	.83333	.694	.501	.717	-1.275	1.400
Question2	2.00	5.00	3.2222	1.09291	1.194	.188	.717	-1.232	1.400
Question3	3.00	5.00	4.2222	.83333	.694	-.501	.717	-1.275	1.400
Question4	3.00	5.00	4.5556	.72648	.528	-1.501	.717	1.467	1.400
Question5	2.00	5.00	3.8889	1.36423	1.861	-.508	.717	-1.917	1.400
Question6	3.00	5.00	3.4444	.72648	.528	1.501	.717	1.467	1.400
Question7	2.00	5.00	3.6667	1.22474	1.500	-.233	.717	-1.556	1.400
Question8	2.00	5.00	3.8889	1.16667	1.361	-.340	.717	-1.579	1.400
Question9	2.00	5.00	3.5556	1.23603	1.528	.092	.717	-1.692	1.400
Question10	3.00	5.00	4.6667	.70711	.500	-2.121	.717	4.000	1.400
Question11	3.00	5.00	4.2222	.83333	.694	-.501	.717	-1.275	1.400
Question12	4.00	5.00	4.7778	.44096	.194	-1.620	.717	.735	1.400
Question13	1.00	4.00	3.0000	1.00000	1.000	-.964	.717	.786	1.400
Question14	1.00	5.00	2.4444	1.42400	2.028	.645	.717	-.543	1.400
Question15	1.00	5.00	2.6667	1.41421	2.000	.417	.717	-1.089	1.400
Question16	2.00	5.00	2.7778	1.09291	1.194	1.289	.717	.770	1.400
Question17	1.00	3.00	2.4444	.72648	.528	-1.014	.717	.185	1.400
Question18	3.00	5.00	4.2222	.97183	.944	-.549	.717	-2.011	1.400
Question19	2.00	5.00	4.1111	1.16667	1.361	-.875	.717	-.808	1.400
Question20	3.00	5.00	3.7778	.97183	.944	.549	.717	-2.011	1.400
Question21	3.00	5.00	3.8889	1.05409	1.111	.271	.717	-2.571	1.400
Question22	1.00	5.00	3.1111	1.26930	1.611	-.260	.717	-.700	1.400
Average	**2.90**	**4.20**	**3.6111**	**.40757**	**.166**	**-.587**	**.717**	**-.152**	**1.400**

Note. N = 9.

Table M3

One-Sample t-test for ISIS Scores

	Test Value 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Question1	-.800	8	.447	-.22222	-.8628	.4183
Question2	.610	8	.559	.22222	-.6179	1.0623
Question3	4.400	8	.002	1.22222	.5817	1.8628
Question4	6.424	8	.000	1.55556	.9971	2.1140
Question5	1.955	8	.086	.88889	-.1597	1.9375
Question6	1.835	8	.104	.44444	-.1140	1.0029
Question7	1.633	8	.141	.66667	-.2748	1.6081
Question8	2.286	8	.052	.88889	-.0079	1.7857
Question9	1.348	8	.214	.55556	-.3945	1.5057
Question10	7.071	8	.000	1.66667	1.1231	2.2102
Question11	4.400	8	.002	1.22222	.5817	1.8628
Question12	12.095	8	.000	1.77778	1.4388	2.1167
Question13	0.000	8	1.000	0.00000	-.7687	.7687
Question14	-1.170	8	.276	-.55556	-1.6501	.5390
Question15	-.707	8	.500	-.33333	-1.4204	.7537
Question16	-.610	8	.559	-.22222	-1.0623	.6179
Question17	-2.294	8	.051	-.55556	-1.1140	.0029
Question18	3.773	8	.005	1.22222	.4752	1.9692
Question19	2.857	8	.021	1.11111	.2143	2.0079
Question20	2.401	8	.043	.77778	.0308	1.5248
Question21	2.530	8	.035	.88889	.0786	1.6991
Question22	.263	8	.799	.11111	-.8646	1.0868
Average	**4.498**	**8**	**.002**	**.61111**	**.2978**	**.9244**

Note. N=9.

SPSS Output for ACT Workbook Data

Table M4

One-Sample t-test for ACT Workbook Standards

	Test Value = 28					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
ACT Standards	-.274	16	.788	-.64706	-5.6516	4.3575

Note: Some teachers have multiple courses. There are 47 standards total. The test value of 35 is equal to 74.5% of the standards.

Table M5

Percentage for Individual Course Data for ACT Curriculum Workbook

Course	13-15	16-19	20-23	24-28	29-32	33-36
Life Science	100	100	66	25	25	0
Physical Science	100	100	100	18.8	25	0
Physical Science	100	100	88.9	0	0	0
Physical Science	50	100	100	75	87.5	71.4
Physical Science	100	100	44.4	37.5	25	0
Physical Science	100	100	44.4	18.8	12.5	42.9
Physical Science	100	100	44.4	37.5	25	28.6
Biology	100	100	100	12.5	37.5	28.6
Biology	100	100	100	50	37.5	28.6
Biology	100	80	88.9	0	0	0
Biology	100	100	100	75	87.5	71.4
Biotechnology	100	100	100	100	100	100
Anatomy and Physiology	100	100	100	75	37.5	87.5
Chemistry I	100	100	100	50	37.5	28.6
Chemistry II	100	100	100	56.3	50	37.5
Physics	100	100	100	56.3	62.5	42.9
Dual Credit Geology	100	100	100	50	37.5	37.5
Average	97.0	98.8	86.9	43.4	40.4	35.6

Note. N = 9. Some teachers have multiple courses. The number of assessed ACT items for each category includes the following: 13-15, 2; 16-19, 5; 20-23, 9; 24-28, 16; 29-32, 8; and 33-36, 7.

SPSS Output for ACT scores converted to ISIS

Table M6

One-Sample t-test for ACT scores converted to ISIS

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
ACTScience	-1176.989	468	.000	-47.93603	-48.0161	-47.8560
ACTCompositeScore	-1134.165	468	.000	-47.98081	-48.0639	-47.8977

Note. N=469. In the converted ACT scale, 0-19=1, 20-23=2, 24-27=3, 28-32=4, 33-36=5.

SPSS Output for Binomial Tests

Table M7

Binomial Test for ACT Scores

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
ACT score	Group 1	22 or less	296	.63	.50	.000
	Group 2	23 or higher	173	.37		
	Total		469	1.00		

Note. 22 out of 36 is equal to roughly 60% on the science ACT.

Table M8

Binomial Test for ISIS Scores

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
ISIS score	Group 1	Less than 3	1	.11	.50	.039
	Group 2	3 or higher	8	.89		
	Total		9	1.00		

Note. A 3 for ISIS equals a score of 66 out of 110 (60%) for individuals.

Table M9

Binomial Test for ACT Workbook Standards

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Workbook Score	Group 1	Less than 28	8	.47	.50	1.000
	Group 2	28 or higher	9	.53		
	Total		17	1.00		

Note. Covering 28 out of 47 ACT standards is equal to roughly 60%.

Table M10

Binomial Test for ACT Scores converted to ISIS

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Converted ISIS score	Group 1	Less than 3	332	.71	.50	.000
	Group 2	3 or higher	137	.29		
	Total		469	1.00		

Note. In the converted ACT scale, 0-19=1, 20-23=2, 24-27=3, 28-32=4, 33-36=5. A 3 for ISIS equals a score of 66 out of 110 (60%) for individuals.

Figures for ACT scores converted to ISIS

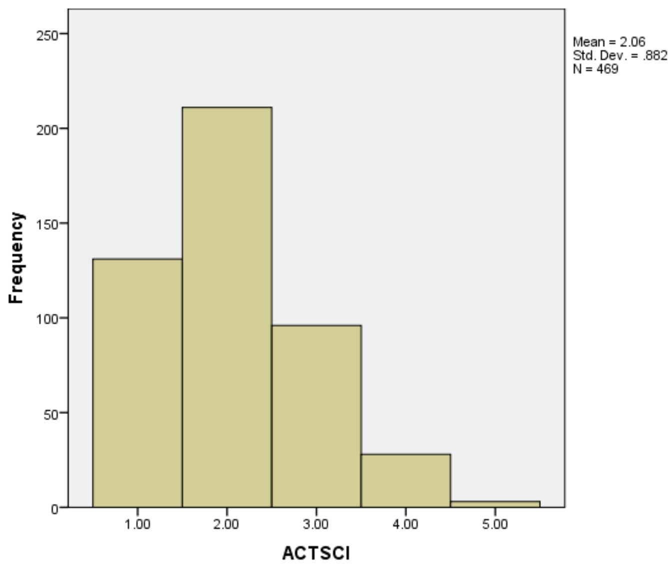


Figure M3. Histogram showing the frequency of science ACT scores when converted to a 5-point scale.

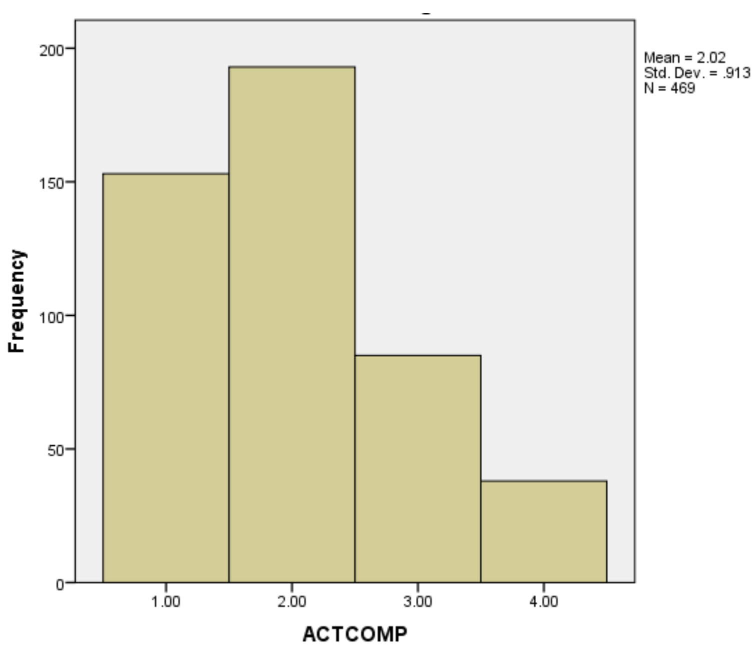


Figure M4. Histogram showing the frequency of composite ACT scores when converted to a 5-point scale.

Appendix N: Copy of the Consent form for Participants

You are invited to take part in a research study about student achievement at a rural high school. You are being asked because you are a high school science teacher. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Cathy Robertson, who is a doctoral student at Walden University. The researcher is also a high school science teacher in the school district and an adjunct science professor at the local community college. This study is independent of my role as a science teacher and faculty member.

Background Information:
This study investigates ways to restructure a science curriculum where the school addresses curriculum deficiencies. The findings of this project study will allow the high school to make decisions pertaining to the science curriculum. The implication for positive social change involves encouraging teachers to participate in ongoing inquiry, which could increase student proficiency, making the students more competitive to colleges and the workforce.

Procedures:
If you agree to be in this study, you will be asked to complete an online survey through Survey Monkey consisting of three parts:

Part One consists of 22 questions. Answering the questions should take 10 to 15 minutes and is utilized to determine the frequency that science teachers are implementing inquiry in the classroom..

Part Two consists of examining your curriculum (for each course taught) and answering questions regarding the inclusion of 47 college readiness standards in science. Answering the questions should take about 30 minutes per course.

Part Three consists of nine questions in terms of describing science inquiry and departmental concerns on the impact on student acquisition of science skills. The questions should take 10-30 minutes to answer.

Voluntary Nature of the Study:
Your participation in this study is voluntary. This means that everyone will respect your decision of whether or not you want to be in the study. No one at St. Clair High School will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind during the study. If you feel stressed during the study, you may stop at any time. You may skip any questions that you feel are too personal. There is no penalty for opting out of the study.

Risks and Benefits of Being in the Study:
All survey questions and answers will be kept confidential. Your answers will be anonymous, even to the researcher. The benefits of the study will come in the form of self-awareness for what is taking place in the classroom and at QRS High School to help students' science achievement and, possibly, a restructured curriculum in which the science department increases the achievement of students.

Compensation:
There will be no compensation of any kind for participating in this study.

Confidentiality:
Any information you provide will be kept confidential. The researcher will not use your information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in any reports of the study.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via e-mail at [redacted] or by telephone at [redacted]. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-612-312-1210. Walden University's approval number for this study is 1-15-14-0179514, and it expires on January 14, 2015.

The researcher will give you a copy of this form to keep.

Statement of Consent:
I have read the above information and I feel I understand the study well enough to make a decision about my involvement. If I choose to participate, my signature will not be collected on this consent form to protect my privacy and my completion of the online questionnaires indicates my consent to the terms described above.

Link for electronic survey: Part One https://www.surveymonkey.com/s/ZR9K6XB
Link for electronic survey: Part Two https://www.surveymonkey.com/s/ZNK96HQ
Link for electronic survey: Part Three https://www.surveymonkey.com/s/ZJYGGSL

Researcher's Written or Electronic* Signature [redacted]

Electronic signatures are regulated by the Uniform Electronic Transactions Act. Legally, an "electronic signature" can be the person's typed name, their email address, or any other identifying marker. An electronic signature is just as valid as a written signature as long as both parties have agreed to conduct the transaction electronically.

Appendix O: Narrative for Central Theme of Interview Questions

One Friday morning in January, the potential participants gathered at 7:30 am to listen to the details of this project study and their requirements, so they could make an informed decision about participating. The meeting had to be at 7:30 am due to a professional development day beginning at 7:50 am. The entire day had been devoted to sessions involving the new Google Chromebooks and technology until 3:30pm, with 15 minute breaks between sessions (to travel in between buildings) and a 30 minute lunch. The teacher's expressed concerns about not having time to work that day and additional time constraints placed on them that year due to the implementation of three extra programs. Due to these concerns, I adjusted the timetable for returning the data.

During the next three weeks, the district had five additional snow days (in addition to the four the first week school the district was to be back in session from winter break, which was when the project study meeting with potential participants was supposed to be held). To complete the data, teachers needed to have their curriculum(s) with them. This added additional vexation for the teachers because, as one participant stated, "I had all this time where I could have been working on the surveys and no resources to actually accomplish my goal…pure frustration."

Curriculum Vitae

Cathy Robertson

Education

- 2014, Doctor of Education, Teacher Leadership, Walden University
- 2011, Education Specialist, Teacher Leadership, Walden University
- 2006, Master of Science, Geoscience, Southeast Missouri State University
- 1999, Bachelor of Science, Geoscience, Southeast Missouri State University

Professional Experience

- 2006-Present, Adjunct Geology Faculty
- 2001-Present, High School Science Teacher

Professional Credentials

- Chemistry Certified
- Earth Science Certified
- Unified Science Certified

Highlights and Contributions

- Participate in science curriculum development as needed
- Teach summer enrichment Physical Science class
- Functioned as Co-Sponsor of the Freshman Class
- Functioned as Co-Sponsor of the Sophomore Class
- Functioned as Co-Sponsor of the Junior Class
- Functioned as Co-Sponsor of the Senior Class
- Function as Co-Sponsor of Science Club
- Function as Co-Sponsor of Key Club

Professional/School Committee Participation

- Missouri State Teachers Association
- Community Teacher Organization (past Treasurer)
- School Advisory Committee
- Science Curriculum Committee