SUSTAINABILITY OF PROFESSIONAL DEVELOPMENT TO ENHANCE STUDENT ACHIEVEMENT: A SHIFT IN THE PROFESSIONAL DEVELOPMENT PARADIGM

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Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

The purpose of this study was to determine the sustainability of professional development—teacher utilization of the Science-in-CTE pedagogical model and science-enhanced CTE lessons—one year following the Science-in-CTE Pilot Study. This study included 27 teachers (15 experimental CTE and 12 science) who participated in the Pilot Study in 2009-2010. This study was a partial replication of the Math-in-CTE Follow-up Study and data were collected using a mixed methods approach. Quantitative data were obtained from online questionnaires and qualitative data were collected from personal and telephone interviews. Data found that a majority of the CTE and science teachers voluntarily incorporated portions of the seven-element pedagogical model and 15 science-enhanced lessons into their curricula one year later. Findings suggest that collaborative professional development is an effective method of integrating science content into CTE curricula to enhance student CTE course achievement without reducing the intent of the CTE program.

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DEDICATION

This thesis is dedicated to my family, friends, and the Agricultural Education profession for their ever-present support. Their belief in me has allowed me to do what I love and love what I do. I, also, dedicate this thesis to the memory of my uncle, Mr. Paul Mizer, who was one of the most creative, enthusiastic, and dedicated educators I have ever known.

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CHAPTER 1. INTRODUCTION

The need for quality professional development is unmistakable. However, the goal of obtaining quality professional development is difficult. Few teachers obtain quality professional development that is content-focused, intensive, and sustainable according to Birman et al. (2007). Teachers have not received effective professional development needed to improve student learning (Kedzior & Fifield, 2004). Yoon, Duncan, Lee, Scarloss, and Shapley (2007) described traditional professional development as "single-shot, one-day workshops that often make teacher professional development 'intellectually superficial, disconnected from deep issues or curriculum and learning, fragmented, and noncumulative'" (Yoon, Duncan, Lee, Scarloss, and Shapley, 2007, p. 1). Typically, many items from traditional professional developments do not meet the needs of all those in attendance. There is a slight chance that teachers will implement the professional development materials into their curriculum and the materials are often placed on a shelf to collect dust, or are, ultimately, discarded into the trash. Young, Edwards, and Leising (2008, 2009) and Stone, Alfeld, Pearson, Lewis, and Jensen (2007) reported on the effectiveness that teacher quality professional development had on increasing student academic scores. Both studies demonstrated the effect Math-in-CTE had within Career and Technical Education (CTE) curricula. The effectiveness and sustainability of professional development in education, the role of CTE in education, and the role of core academic areas in CTE are components that were addressed in the Math-in-CTE study (Lewis & Pearson, 2007). The study integrated math-enhanced lessons that naturally occurred in CTE courses. The intensity of professional development received was cited as a leading factor of the study's success.

A Math-in-CTE Follow-up Study (Lewis & Pearson, 2007) was conducted in the spring of 2006 with the participants from the national Math-in-CTE Research Study that included 60

experimental CTE teachers, 52 mathematics teachers, and 73 control teachers. Based on the mixed-methods data that were collected from the original study, experimental teachers felt that professional development was vital to understanding and properly using the seven-element pedagogical model. Teachers believed success was due to the intensiveness of ten days of professional development throughout the study. New learning communities were created between the CTE and mathematics teachers. Data from the follow-up study determined that three-quarters of the experimental teachers reported continued use of the pedagogic model and the math-enhanced lessons developed during the study. Control teachers who received minimal professional development reported limited effectiveness (Lewis & Pearson, 2007).

A Science-in-CTE Pilot Study was conducted in 2009-2010 among 41 North Dakota Agricultural Education and science teachers. Based on the support that the Math-in-CTE Follow-up Study provided for the initial Math-in-CTE study, it was determined that a similar follow-up study should be conducted for the Science-in-CTE Pilot Study. It would be beneficial to know if science-enhanced curricula and extended professional development could have as much of a sustaining impact on Career and Technical Education and science educators and students as was observed with the Math-in-CTE participants.

Purpose of the Study

The purpose of this research was to determine the sustainability of professional development among teachers who participated in the Science-in-CTE Pilot Study. Specifically, this follow-up study was developed to explore teacher utilization of the Science-in-CTE pedagogical model and CTE science-enhanced lessons in curricula one year following the Pilot Study. The information obtained from this follow-up research study is beneficial to secondary

Career and Technical Education and science teachers. Professional development practices and pedagogy among teacher educators would also benefit from this follow-up study.

Focus

This follow-up study focused on 27 CTE and science teachers who participated in the Science-in-CTE Pilot Study in North Dakota during 2009-2010. This study was conducted one year following the conclusion of the Pilot Study.

Research Questions for the Study

The following research questions were used to guide this study:

1. To what extent would experimental CTE teachers who participated in the North Dakota Pilot Study continue to use the pedagogical model and specific lessons that had been developed for the study after the experiment ended?
2. To what extent are science teachers who worked with the CTE teachers using the pedagogical model or any of the occupational examples from the lessons developed in their academic classes?
3. To what extent do experimental CTE teachers believe their students' CTE course achievement was enhanced after using the lessons developed for the Pilot Study?
4. To what extent do experimental CTE teachers believe the CTE curricula was reduced with the implementation of the enhanced science concepts?

Significance of the Study

Information obtained from this follow-up research study is important to secondary Career and Technical Education and science teachers, especially in North Dakota as a new and effective delivery of professional development could benefit all educators regardless of their content area. Increased communities of practice might be established across curricula and disciplines. Educators who complete professional development strategies addressed in the Science-in-CTE Pilot Study would have the tools necessary to continue to develop effective lesson plans that have been peer-reviewed and immediately available, as well as the support from other educators within and outside of their content area.

Limitations of the Study

The Science-in-CTE Follow-up Study was subjected to the following limitations:

- Timing of follow-up. The original Science-in-CTE Pilot Study was completed in June 2010. Therefore, the teacher follow-up was conducted during the last couple weeks of school and during summer break. Teachers may have been distracted with end-of-the-year teaching requirements or summer activities.
- Voluntary participation. Teachers voluntarily participated in this follow-up study and, as such, could be considered innovators and could have a pro-research bias. They were given the freedom to withdraw from the study at any time and without prior notice.
- Ability to recall. Given that the follow-up study is conducted one year after the conclusion of the original study, data are subject to each teacher's ability to recall the lessons and their pedagogical practices for the past school year.

- Loss of participants. With the transition into another school year, participants may have become unavailable due to retirements, career changes, health issues, or other factors.
- Small sample size. This follow-up study was conducted only with Agricultural Education and science teachers in North Dakota. It may have limited application to educators in other disciplines and/or geographic areas.
- Alternating curricula. Some of the Agricultural Education programs in North Dakota alternate their curriculum between semesters and/or years (i.e. plant sciences will be taught on even years and animal sciences will be taught on odd years; animal sciences are taught first semester and plant sciences are taught second semester).

Organization of Remaining Chapters

This thesis was organized using five primary chapters. Chapter 2 provides a literature review of CTE and Agricultural Education curricula and practices, traditional professional development methods, and the behavior of change. Chapter 3 addresses the methods used in obtaining the data from a mixed-methods approach and an analysis of the data collected is presented in Chapter 4. Chapter 5 presents a summary of findings and recommendations for future research.

Definition of Terms

The following terms were used in reference to this research study:

Seven-element pedagogical model- Originally designed for the Math-in-CTE research studies, a seven-element pedagogy model "was designed to move CTE students

gradually from a contextual understanding of mathematics to a more abstract understanding such as that required on many standardized tests" (Stone, Alfeld, Pearson, Lewis, & Jensen, 2007, p. v). Slight modifications were made to reflect the science focus used in the Science-in-CTE Pilot Study. Experimental teachers designed science-enhanced lessons using the process described in Figure 1.

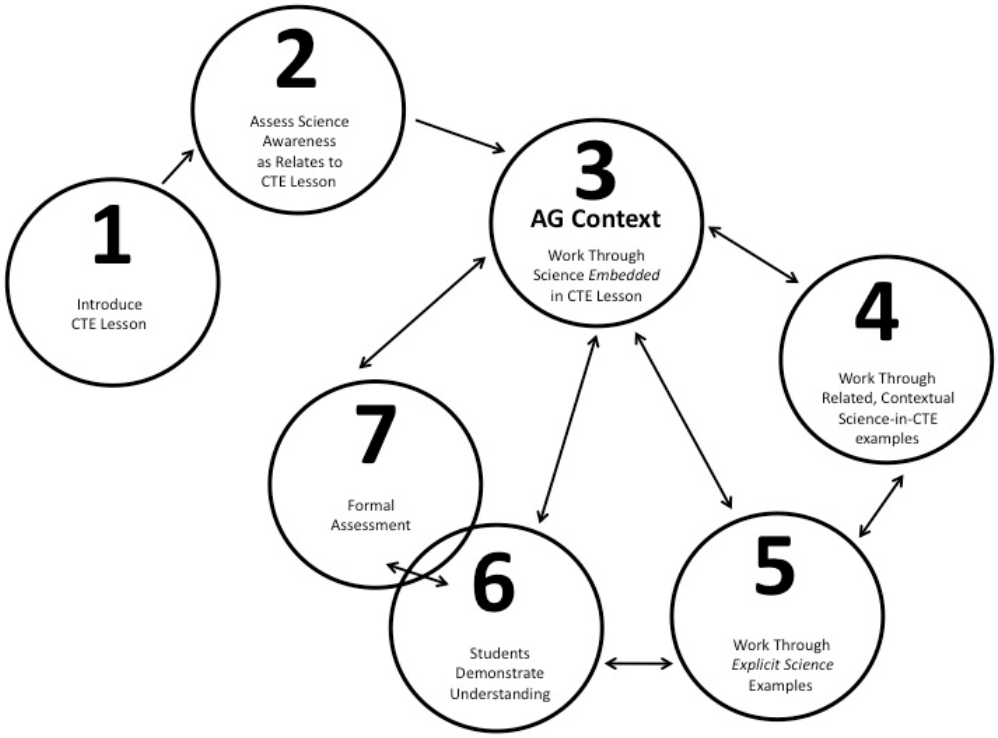

Figure 1. The Seven-Element Pedagogical Model for Science.

Science-enhanced lesson- Science-enhanced lessons were developed using the same process teachers used in the Math-in-CTE research studies. Slight modifications were made to reflect the science content and teachers. The Math-in-CTE enhanced lesson process was described by Stone, et al. (2007):

In a series of professional development workshops, the experimental CTE teachers worked with math teachers to examine the CTE curricula and identify the embedded mathematical concepts. The teams then developed instructional activities that the CTE teachers used to enhance the teaching of math that already existed (but was previously not emphasized) in the CTE curricula. (p. v)

CHAPTER 2. LITERATURE REVIEW

The Changing Role of Career and Technical Education (CTE)

The History and Growth of Career and Technical Education in America by Howard Gordon (2008) described the circumstances that led to the development and continuation of what was formerly referred to as vocational education. Vocational education was implemented through apprenticeships, shop work, and manual trainings. As vocational education was introduced into the public school system, advancements were made that included laboratory work and instruction by a trained teacher. Throughout history, various factors and leaders influenced the development of vocational education and federal legislation had been enacted to support vocational instruction. A variety of changes were made to vocational education via legislation over the years.

In 1998, the Carl D. Perkins Vocational and Technical Education Act, Public Law 105-332 (USDE, 2002), hereby referred to as the Perkins Act, defined vocational-technical education as educational programs that prepare students for employment in occupations that do not require a Bachelor's or advanced degrees. Other requirements included learning that was competency-based, applied, and occupationally-specific, as well as learning that included higher-order reasoning and problem-solving skills.

The No Child Left Behind (NCLB) Act of 2001 established additional criteria for educators. Of immediate concern to CTE teachers were mandates for highly qualified teachers and state accountability. Based on the guidelines that defined CTE programs, some CTE teachers found it difficult to adhere to NCLB's requirement that all teachers become highly qualified. CTE licensure and certification vary from state to state. Some CTE teachers enter the profession through trade and industry, while others enter through the traditional teacher

education route. Some CTE teachers teach a course that carries partial credit toward a core academic course that can be used to fulfill graduation requirements and this, also, varies from state to state. Under the NCLB Act, CTE teachers found it difficult to achieve highly qualified status with the United States Department of Education (Kymes, 2004).

Another key component of the NCLB Act was the requirement for state accountability. Similar to the highly qualified status that varied from state to state, each state was charged with determining its own set of academic content standards and an appropriate means of evaluating the standards. Some states were already utilizing state assessments for core academic areas. However, other states were required to adopt state assessments to begin testing their students. It has not been a simple process for CTE programs to implement standardized assessments due to the nature and diversity of their programs (Kymes, 2004).

CTE programs have felt the effects of educational reforms. Martin, Fritzsche, and Ball (2006) ascertained that budget restraints, funding issues, and loss of Perkins funding were key concerns for CTE programs. NCLB and the Perkins Act, at the national level, hold the key to funding by determining the dispersal of funds based on state student assessments. Therefore, local Boards of Education must make difficult choices. These choices have included the addition or removal of various programs and qualified teachers, as well as necessary changes in curricula to reflect instruction of material measured on state-mandated assessments.

The Perkins Act was updated in 2006 when Congress implemented the Carl D. Perkins Career and Technical Education Improvement Act of 2006, or Perkins IV. One change included the transition from the term vocational education to career and technical education. Language was removed that limited the educational training to occupations that did not require advanced degrees and opened it up to address career and technical education that could be utilized in

further educational and career opportunities. While much of the learning criteria were maintained from the Perkins Act, one of the main focal points of Perkins IV was the emphasis on "rigorous content aligned with challenging academic standards" (Carl D. Perkins, 2006, Section 3, 5Ai). This increased the resourcefulness of integrating core academic content into Career and Technical Education curricula. Attention was given to science, technology, engineering, and mathematics (STEM) education.

The Alliance for Education (2012) described STEM as an "initiative for securing America's leadership in science, technology, engineering, and mathematics fields and identifying promising strategies for strengthening the educational pipeline that leads to STEM careers" (p. 1). Global competition quickly has increased and the United States has fallen behind other countries especially in the areas of science, technology, engineering, and mathematics (ACTE, 2009; Sabochik, 2010). Section 2, subsection 7, of Perkins IV (2006) specifically addressed this issue that CTE programs are to provide students with competencies necessary for the United States to be competitive. A challenge of core academic integration is getting students enrolled in courses that promote STEM areas of study and career opportunities. CTE courses can provide a natural integration of science content within practical applications (ACTE, 2009).

Perceptions of Academic Integration into Career and Technical Education

Perkins IV and NCLB indicated the necessity of CTE teachers to integrate core academics into the CTE curricula and to be accountable for academic standards that are evaluated through statewide student assessments. However, some CTE teachers opposed these mandates for various reasons. In a study conducted by Martin et al. (2006), 15 secondary Agricultural Education teachers identified impacts of NCLB to secondary CTE programs. Many

of the impacts addressed budgeting constraints, loss of Perkins and state funding, and a loss of CTE teachers. However, CTE teachers also expressed concern for the decrease in the number of agriculture courses taught and the mandatory integration of core academics into CTE curricula. When asked to rank their responses, teachers from the study felt that the primary concern was the increase in core academic courses students were required to complete for high school graduation. These increased course requirements made it more difficult for students to enroll in elective courses, thus causing a decrease in enrollment in Agricultural Education courses. Overall, teachers from the study felt NCLB would cause a negative impact on CTE programs.

Secondary Agricultural Education teachers have genuine concerns about the impact core academic integration will have on CTE programs. Additionally, CTE teachers are concerned about time constraints with a curriculum that is already full, a perceived reduction in the CTE curricula and students' CTE course achievement, possessing the confidence and competence to teach academic content, and obtaining proper training and professional development (Thompson, 1998; Lewis & Pearson, 2007; Warnick & Thompson, 2007; Parr, Edwards, & Leising, 2008; Myers, Thoron, & Thompson, 2009; Scales, Terry, & Torres, 2009; Young, Edwards, & Leising, 2009). Lewis and Pearson (2007) conducted a follow-up study with 43 CTE teachers to determine why they did not include explicit math instruction in their CTE curricula. Over half of the teachers indicated that they did not have enough time to incorporate core academic content in their CTE curricula because of the excessive amount of occupational content that needed to be taught. Likewise, Myers, Thoron, and Thompson (2009) conducted a study with 25 Agricultural Education teachers who participated in the 2007 National Agriscience Teacher Ambassador Academy. Sixty-eight percent of the teachers felt that there was not a sufficient amount of time to incorporate science into their curricula. However, all of those teachers also believed that

integrating science into their curricula would make science concepts easier for their students to understand and increase their problem-solving skills (Myers et al., 2009). The study also found that 88% of the teachers believed that their students had a better response to the CTE curricula when science content was integrated. Regardless of the CTE teachers' confidence or perceived ability to incorporate core academic content into their curricula, Scales, Terry, and Torres (2009) warned "confidence to teach science should not be confused with competence to teach science" (p. 108).

Aside from individually enrolling in continuing education courses, how can CTE teachers become more confident and competent to incorporate core academics into their CTE curricula? In 2004-2005, the National Research Center for Career and Technical Education conducted a study to determine if students' math performance could be improved after receiving a math-enhanced CTE curriculum. The Math-in-CTE study involved 136 CTE teachers and nearly 1,600 CTE students. Teachers were divided equally into two groups—experimental and control. The control teachers taught the CTE curriculum as they had planned. The experimental teachers were each partnered with a mathematics teacher prior to teaching math-enhanced lessons. The experimental teacher teams received 10 days of intensive professional development that spanned the 2004-2005 school year. Teacher teams designed math-enhanced CTE lessons using a seven-element pedagogical model. All lessons were peer reviewed and taught in the experimental CTE teachers' programs. Students were divided into thirds at the end of the study and tested with one of three post-tests—TerraNova, Accuplacer, or WorkKeys. Results from two of the three tests indicated a significant difference in the math performance of students in the experimental group who received the math-enhanced CTE lessons as compared to students from the control group who had not received a math-enhanced curriculum. Experimental students' math achievement

was 9% higher on the TerraNova and 8% higher on the Accuplacer assessments as compared to control students (Stone, Alfeld, Pearson, Lewis & Jensen, 2005; Lewis & Pearson, 2007; Stone, et al., 2007; ACTE, 2009).

An implementation of core academics into CTE curricula does not constitute a decrease in the degree and effectiveness of the CTE curricula itself or the students' course achievement. Two smaller studies were conducted to analyze whether or not the integration of a math-enhanced curriculum would decrease students' CTE course achievement and competencies (Parr et al., 2008; Young et al., 2009). Both studies utilized CTE experimental and control groups. Experimental CTE teachers were partnered with mathematics teachers for the duration of the study. The study by Parr, Edwards, and Leising (2008) was conducted during spring semester of 2004 and involved 18 experimental classrooms. Young et al. (2009) conducted another study in the fall of 2004 and spring of 2005 that included 16 experimental classrooms. In both studies, the results were similar—the inclusion of a math-enhanced curriculum did not reduce the CTE skills obtained by students. Findings from other studies (Thompson, 1998; Warnick & Thompson, 2007; Myers et al., 2009) also supported the perceptions that integration of core courses into CTE curricula is an effective method of teaching Agricultural Education and raising student achievement.

Regardless of CTE teachers' hesitation to integrate core academics into their CTE curricula, studies have shown that teachers' concern for their students' success outweighed their perceived barriers. CTE teachers have offered rigorous, applicable, and content-specific curricula that are strong in science, technology, engineering, and mathematics. According to Scales et al. (2009), "If agriculture instructors are going to be expected to teach science concepts, there must be an effective and focused inservice program designed to increase their knowledge

about science and to expose them to the methods used to teach this content" (pp. 108-109). Therefore, how can we train teachers more effectively to integrate core academic content without loosing the CTE focus?

Views on Professional Development

The NCLB Act of 2001 and Perkins IV have had a significant impact on CTE instruction and overall professional development. Professional development was outlined in Title IX (2001) of NCLB and included the following criteria:

> Includes activities that are high quality, sustained, intensive, and classroom-focused in order to have a positive and lasting impact on classroom instruction and the teacher's performance in the classroom; are not 1-day or short-term workshops or conferences; are developed with extensive participation of teachers…served under this Act; are regularly evaluated for their impact on increased teacher effectiveness and improved student academic achievement, with the findings of the evaluations used to improve the quality of professional development; provide follow-up training to teachers who have participated in activities…that are designed to ensure that the knowledge and skills learned by the teachers are implemented in the classroom (Section 901, Subsection 34A-34B).

However, traditional professional development could often be described as one-day workshops that are held during the school day, fragmented to cover a variety of content or topics, and involved fun activities that produced little or no improvement to teaching pedagogy (Ruhland & Bremer, 2002). In a study by Ruhland and Bremer (2002), 12 of 14 beginning teachers said they had some type of professional development during their first year. The level and quality of the professional developments varied and none of the participants indicated any state-sponsored activities.

It is difficult to provide all-inclusive professional development to diverse teachers and programs in a single school building or district, as well as finding the right content to present.

Kedzior and Fifield (2004) addressed barriers that potentially hindered quality professional development such as the structure and content of the professional development, the educator's time, school and district factors, and costs associated with providing the professional development. Time was an issue both during and after school hours and, in both instances, other school and district factors outweighed dates and times professional developments could be scheduled. Costs were often listed as a reason for reduced or cancelled professional development because providing high quality professional development could be time consuming and expensive for a school or district.

Boardman and Woodruff (2004) addressed four strategies of professional development that are vital to sustainable teaching and learning opportunities. First, teachers appear less concerned with how professional development is delivered if it provides quality content. However, teachers still expect overall effective professional development. Second, teachers expect new information that is content-specific, has practical applications, and is relevant to their program. Third, teachers value observations, feedback, and reflection. Observations and feedback can be obtained from peers, administrators, and others in a timely manner. It is vital that teachers allow time for reflection during and after a lesson is taught so that any necessary adjustments may be made to the remainder of the lesson or the next time it is taught. Fourth, the beliefs, attitudes, and investment on the teacher's part are vital in determining whether a teacher will implement and maintain change in their pedagogy.

A Shift in Pedagogy

How can teachers shift their pedagogy to effectively integrate core academics into their CTE curricula without loosing the true nature of the CTE content? Four decades ago, it was

apparent that changes in attitudes would be necessary in order for in-service opportunities to be effective (Bush, 1971). Forty years later, it is still imperative that teachers maintain a positive attitude about professional development opportunities and agree to change their pedagogy when necessary. Presently, Perkins IV requires CTE teachers to change their method of teaching CTE curricula by incorporating core academic content into their programs of instruction.

There are various models of change that could be employed to help teachers modify their pedagogy. One such method is the transtheoretical model of behavior change (Prochaska, Johnson, & Lee, 2009; Prochaska, DiClemente, & Norcross, 1992). The model addressed five stages of change—precontemplation, contemplation, preparation, action, and maintenance. In the precontemplation stage, individuals are not planning to make any changes in the near future. Contemplation means that individuals fully intend to change in the near future. At the next stage, preparation, individuals not only have a plan for change, but they intend to make it happen within a month. The action stage is where the change occurs. After a change has occurred, it is necessary to refrain from returning to the undesired behavior. Therefore, the maintenance stage is a preventative stage and typically individuals will spend a majority of their time in this stage. A sixth stage that is more often unattained is the termination stage. When an individual has succeeded in making the change and preventing a setback, they can proceed to the termination stage. At the termination stage, an individual is able to maintain the desired behavior from this point forward without hesitation or temptation (Prochaska et al., 1992). Prochaska, Prochaska, and Levesque (2001) addressed issues of resistance or readiness to change within an organization. Often times, leaders of change have already spent a considerable amount of time in the preparation stage and are prepared for the action stage. However, if the other individuals

in the group have not completed their own preparation stage, the efforts of the leader will have been in vain and they may be met with a great deal of resistance to the notion of change.

How does the transtheoretical model of behavior change relate to professional development and academic content integration? CTE teachers are at varying stages of change as they integrate core academic content into their CTE programs to align with Perkins IV and NCLB legislations. Similarly, traditional professional development practices are not aligned with teachers' attitudes, and thus, will not be effective in producing and maintaining teacher change. In a study of more than 1,000 mathematics and science teachers, collective participation was listed as one of the characteristics that make professional development effective (Garet, Porter, Desimone, Birman, and Yoon, 2001). Collaborative professional development can be used to bring about positive and effective change to CTE and core academic teachers.

CHAPTER 3. METHODOLOGY

The purpose of this study was to determine the sustainability of professional development—teacher utilization of the Science-in-CTE pedagogical model and Career and Technical Education (CTE) science-enhanced lessons in curricula one year following the Pilot Study. The North Dakota Science-in-CTE Follow-up Study was a partial replication of the Math-in-CTE Follow-up Study. Therefore, it is important to briefly note the methods and procedures followed in the Math-in-CTE Follow-up Study and the North Dakota Science-in-CTE Pilot Study that were instrumental in the successful completion of the North Dakota Science-in-CTE Follow-up Study.

Background of the Math-in-CTE Follow-up Study

The National Research Center for Career and Technical Education (NRCCTE) Math-in-CTE Follow-up study (Lewis & Pearson, 2007) evaluated the extent to which teachers used the Math-in-CTE model and explicit math lessons one year following the completion of the Math-in-CTE Study. The follow-up was conducted during the 2005-2006 school year.

The study used a mixed-methods approach to data collection. Surveys were mailed to 185 CTE and mathematics teachers to collect quantitative data in the Math-in-CTE Study. Participants who completed and returned the survey were given a $50 honorarium. Teachers who reported using explicit math instruction in their curricula participated in a personal interview that lasted approximately 40-60 minutes each. During the personal interviews, teachers were asked to verbally walk through two randomly selected lessons they had indicated using on their initial survey. These lessons were originally developed in the Math-in-CTE Study using a seven-element teaching model. Teachers submitted qualitative data by providing student

artifacts from both lessons. An additional $50 honorarium was given for completion of personal interviews. Qualitative data were collected from telephone and personal interviews that were recorded and later transcribed and analyzed. The data provided were used to support and expand upon themes identified from the quantitative data.

The Math-in-CTE Follow-up Study documented the sustainability of mathematics and CTE teachers to utilize the math-enhanced CTE lessons a year after the structured professional development. Researchers wanted to see if similar results could be obtained with a Science-in-CTE Study.

Background of the Science-in-CTE Pilot Study

The North Dakota Science-in-CTE Pilot Study (Pearson et al., 2010) was a partial replication of the Math-in-CTE Study. In the North Dakota Science-in-CTE Pilot Study, an open invitation to participate in the study was sent to all 77 North Dakota secondary Agricultural Education CTE teachers listed in the teacher directory (NDAAE, 2009) in the fall of 2009. A total of 29 CTE teachers responded and represented 29 different schools in the state. CTE teachers were randomly assigned to experimental and control groups of approximately equal size. Fifteen of the 29 Agricultural Education teachers were assigned to the experimental group and 14 teachers were assigned to the control group. Experimental CTE teachers were paired with a secondary science teacher partner for the duration of the study. In total, 41 teachers (experimental CTE, control CTE, and science) were involved in the North Dakota Science-in-CTE Pilot Study.

The Pilot Study was conducted in the late fall of 2009 and spring of 2010. The experimental debriefing was conducted in June 2010 and the control debriefing in September

2010. All teachers (CTE and science) completed pre- and post-teacher questionnaires. CTE students in the experimental group were taught the science-enhanced lessons, while CTE students in the control group were not exposed to any of the science-enhanced lessons developed in the study and were taught using the traditional Agricultural Education curriculum. All CTE students were post-tested to determine their science knowledge and ability at the conclusion of the study. Instructional artifacts were collected from both the experimental and control groups.

Twelve science teachers were partnered with experimental CTE teachers, with three science teachers assisting a second CTE teacher partner. Extended professional development and supporting materials were provided to the experimental teachers between December 2009 and June 2010—two days each in December, January, and March—and one day for debriefing and focus groups in June. Science-enhanced CTE lesson plans were developed by the teacher partners and evaluated by their peers. Each CTE teacher in the experimental group taught all 15 lessons to their students. Science teachers completed pre-teaching reports for their partner of each lesson that the CTE teacher planned to teach. CTE teachers completed post-teaching reports for each lesson completed. Experimental CTE teachers provided student artifacts from each of the lessons.

The control group did not receive any additional professional development, science partner assistance, or supporting materials. Control teachers were asked to continue teaching the traditional CTE curricula. Control teachers were brought together for one session in September 2010 for a debriefing that included an explanation of the seven-element pedagogical model and presentation of lesson materials.

A Need for the North Dakota Science-in-CTE Follow-up Study

A follow-up study was needed to determine the sustainability of seven days of intensive professional development between secondary CTE and science teachers. Sustainability can be determined by evaluation of the following components: (a) the extent to which experimental CTE teachers continued to use the pedagogical model and science-enhanced lessons that were developed for the Pilot Study, (b) the extent to which experimental science teachers incorporated the pedagogical model and any of the occupational examples from the CTE lessons into their core academic course(s), (c) the extent to which experimental CTE teachers believed their students' CTE course achievement was enhanced after using the lessons developed for the Pilot Study; and (d) the extent to which the CTE teachers believe their CTE curricula was reduced due to implementation of the enhanced science concepts.

Population

The population of this research study included the 27 North Dakota secondary CTE and science teachers who participated in the North Dakota Science-in-CTE Pilot Study. The 15 experimental CTE teachers represented the 77 Agricultural Education teachers in North Dakota during the 2009-2010 school year. The remaining 12 teachers in the study were North Dakota secondary education science teachers.

Design of the Study

The idea of a Science-in-CTE follow-up study was discussed with the coordinators of the Pilot Study developed by the National Research Center for Career and Technical Education (NRCCTE). It was determined that NRCCTE would not be conducting their own follow-up

study, yet there was an expressed interest in discovering the sustainability of the science-enhanced CTE lessons that were developed using the seven-element teaching model. The Follow-up Study was designed to investigate the extent to which Agricultural Education CTE teachers continued to use the science-enhanced lessons and seven-element teaching model one year after the conclusion of the Pilot Study. The North Dakota Science-in-CTE Follow-up Study was a partial replication of the Math-in-CTE Follow-up Study. It was determined that similar components would be utilized in the science follow-up—a questionnaire and personal and telephone interviews. Slight modifications were made to reflect the needs within the academic science content and North Dakota Career and Technical Education programs.

Data Collection

Prior to any research being conducted, permission was obtained from the North Dakota State University Institutional Review Board (IRB) (see Appendix A). Questions and dialogues used in the Science-in-CTE Follow-up Study were adapted from the Math-in-CTE Follow-up Study with expressed written permission from NRCCTE.

A mixed-methods research approach to data collection was used (Creswell, 2002). The online questionnaire was designed to conduct survey research that primarily obtained quantitative data. The questionnaire included some open-response questions where qualitative data were analyzed. Qualitative data were collected through personal and telephone interviews. Responses from the personal and telephone interviews were later compared to responses from the questionnaires to further evaluate the extent of use or justification of non-usage of the science-enhanced lessons.

The questions included on the questionnaire were derived from the Math-in-CTE Follow-up Study that had been previously conducted. Slight modifications were made to reflect the science content and programming of North Dakota Agricultural Education teachers. A panel of experts reviewed the questions to determine content validity. The panel consisted of North Dakota State University Teacher Educators specializing in the areas of Agricultural Education, Family and Consumer Sciences, and Science, as well as staff from the National Research Center for Career and Technical Education.

Procedure

On May 26, 2011, an invitation to participate in an online questionnaire was e-mailed to the 27 North Dakota CTE (see Appendix B) and science (see Appendix C) teachers who participated in the Pilot Study. The invitation included a secure link to SurveyMonkey® to complete the online questionnaire. Informed consent letters were attached with each e-mail invitation to CTE experimental and science teachers (see Appendices D and E, respectively).

Since the timing for the follow-up was near or at the end of the school year, teachers who did not respond within a week and a half were sent an e-mail reminder in early June of 2011. Due to a natural disaster that affected many of the teachers and their schools throughout the summer months, preparations for a new school year, and some teachers asking if there was still time to participate in the follow-up study, a decision was made to make one final attempt to invite teachers to complete the online questionnaire. Therefore, a final reminder was e-mailed on September 14, 2011, inviting any teachers who had not yet completed the online questionnaire to still participate in the follow-up study. Of the teachers who were contacted in September, a

majority of the remaining teachers completed their online questionnaire within 24 hours of this final invitation.

Online Questionnaire

The purpose of the online questionnaire was to ascertain to what extent teachers were using the pedagogical model or any of the science-enhanced CTE lessons originally developed for the Pilot Study. The researchers used SurveyMonkey® online survey software to design the online questionnaires. Teachers were able to access their assigned questionnaire through a secured SurveyMonkey® link. Teachers were offered a $50 honorarium for completing the online questionnaire as a means to promote a high participation rate. However, all teachers were given the opportunity to opt out of the online questionnaire at any time. The links for the online questionnaires were made available on March 26, 2011 and disabled on September 22, 2011. Participants were only permitted to log into the online questionnaire once.

Two specific online questionnaires were developed and geared toward the respective group—CTE experimental and science teachers (see Appendices F and G, respectively). Questions initially stemmed from the Math-in-CTE Follow-up Study, but slight modifications were made to reflect the needs and interests of science and CTE teachers in North Dakota. The design of the online questionnaires was established using contingency questions (Lavrakas, 2008). As participants answered questions, they were automatically directed to a corresponding question on the questionnaire. For example, if a participant indicated they had included explicit science instruction, they were directed toward the next question dealing with the specifics of that science instruction. However, if a participant indicated on the questionnaire they had not included any explicit science instruction, they were directed past any questions relating to the

specifics about science instruction. Rather, they were directed to a question to clarify their negative response.

Using contingency questions, affirmative responses from CTE teachers elicited additional in-depth questions about the amount of contact with science teacher(s), lesson usage and/or modification, and adoption of the seven-element pedagogical model. CTE teachers also indicated their belief as to the extent that their students' Agricultural Education course achievement was enhanced after using the lessons developed for the study, as well as the extent to which their Agricultural Education curricula were reduced with the implementation of the enhanced science concepts. CTE teachers who indicated they were not teaching secondary Agricultural Education courses or using any of the explicit science instruction during the 2010-2011 school year were directed to indicate their reason(s) for not using the Science-in-CTE resources.

Contingency questions were used on the science teachers' online questionnaire as well. When participants answered affirmatively, they were directed toward additional in-depth questions about the types of agricultural examples used, amount of contact with Agricultural Education teachers, lesson usage, and adoption of the seven-element pedagogical model. Science teachers who indicated not teaching science courses or including any of the methods or examples from the lessons were directed to indicate their reason(s) for not using the Science-in-CTE resources.

While the questionnaire included questions to gauge the degree of usage of the lessons and model, qualitative data were also collected through personal and telephone interviews from teachers who responded to the questionnaire. Upon completion of the online questionnaire, CTE and science teachers who indicated using at least portions of the lessons or model were asked to

consent to a personal follow-up interview to verify their questionnaire responses and to gain a better understanding of the two teaching tools used. Teachers who indicated on the questionnaire that they were not using the lessons or model were given the opportunity to consent to a telephone follow-up interview to shed light on their negative response.

Interviews

Based on the completed online questionnaire, CTE teachers who indicated using explicit science instruction or parts of the pedagogical model in their lessons were contacted by telephone or e-mail and invited to participate in personal interviews (see Appendix H). An interview script was used to establish an interview date, time, and location (see Appendix I). In-depth personal interviews were used to verify the teachers' questionnaire responses and gain a better understanding of how the model and lessons were used. All personal interviews began with the researcher reading a personal interview consent script (see Appendix J). Personal interview questions were used to establish continuity within the CTE group (see Appendix K). However, the script provided the researcher with some flexibility to ask clarifying questions based on participant responses. Science teachers who indicated using methods, materials, or agricultural examples from the Science-in-CTE Pilot Study were invited to complete a personal interview (see Appendix L). Personal interview questions used for science teachers can be found in Appendix M. For science teachers, the personal interviews lasted an average of 25-35 minutes for science teachers and 40-60 minutes for CTE teachers.

All personal interviews (CTE and science) focused on two random lessons the teachers indicated they had taught in its entirety or a portion. Small tags were numbered one through 15 and corresponded with the 15 science-enhanced lessons from the Science-in-CTE Pilot Study.

Numbered tags were placed into a hat based on the lesson numbers teachers had indicated having taught and two tags (lessons) were randomly selected. During the personal interview, teachers verbally walked through the lessons as they had taught them, describing the lessons using the seven-elements in the pedagogical model (see Appendix N). All personal interviews were audio recorded. To compensate them for their time, teachers who completed a personal interview were given an additional $50 honorarium.

CTE teachers who reported not using the lessons or model, and science teachers who reported not utilizing any of the methods, materials, or agricultural examples were contacted by telephone or e-mail inviting them to participate in a short telephone interview (see Appendices O and P, respectively for CTE and science teacher telephone interview invites). Telephone interview consent scripts were read at the beginning of each telephone interview followed by a brief set of interview questions (see Appendix Q for the telephone invite and Appendix R for the telephone interview questions). Telephone interviews were used to verify whether participants had used any part of the science model and lessons and their reasoning for not including them into their curricula. No additional honorarium was offered for telephone interviews. The telephone interviews typically lasted 10-15 minutes and were conducted during a scheduled time as indicated by the teacher. All telephone interviews were audio recorded.

Research Design

As previously mentioned, a mixed methods research approach to data collection was used. Quantitative data were obtained from the online questionnaires. Qualitative data were collected through personal and telephone interviews. Although the primary purpose of the online questionnaires was to obtain quantitative data, some additional qualitative data were also

obtained. The qualitative data received from the online questionnaires and interviews were used to determine the extent of use or justification of non-usage of the science-enhanced lessons.

Analysis

The online questionnaires were collected via SurveyMonkey® and maintained by the researchers. The questionnaires were downloaded into Excel spreadsheets to determine which participants consented to an additional personal or telephone follow-up interview.

All qualitative data, telephone and personal interviews, were audio recorded. Recordings were transcribed using Dragon Dictate software. The recordings and transcripts were independently analyzed and coded. Through the coding process, broad themes were identified. These themes were then used to verify findings from the quantitative data.

CHAPTER 4. RESULTS

The findings of the data collected from the North Dakota Science-in-CTE Follow-up Study are found in this chapter. Data were collected from 27 North Dakota Career and Technical Education (CTE) and science teachers who participated in the Science-in-CTE Pilot Study in 2009-2010. The follow-up study was conducted one year following the completion of the Pilot Study.

Data presented in this chapter are in the same order as the research questions that were previously stated in Chapter 1. First, an analysis was conducted that determined the extent to which experimental CTE teachers who participated in the North Dakota Pilot Study continued to use the pedagogical model and specific lessons that had been developed for the study after the experiment ended. Second, an analysis was conducted that determined the extent to which science teachers who worked with the CTE teachers used the pedagogical model or any of the occupational examples from the lessons developed in their academic classes. Third, data were analyzed to determine the extent to which experimental CTE teachers believed their students' CTE course achievement was enhanced after using the lessons developed from the Pilot Study. Fourth, an analysis was conducted to determine the extent experimental CTE teachers believed the CTE curricula was reduced with the implementation of enhanced science concepts.

Response Data Analysis

Invitations to participate in the North Dakota Science-in-CTE Pilot Study were e-mailed to 27 CTE and science teachers who participated in the Science-in-CTE Pilot Study. There were 15 CTE teachers in the experimental group and 12 science teachers. Twenty-five out of 27 experimental and science participants completed the online questionnaire for an overall response

rate of 94%. Teachers who were invited to participate and those who completed the online questionnaire are presented in Table 1. All 15 Agricultural Education teachers (100%) from the experimental group completed the online questionnaire and 10 of the 12 science teachers (83%) completed the online questionnaire.

Table 1.

Invitations E-mailed and Online Questionnaires Completed

Teacher Group	E-mailed	Questionnaires Completed	Response %
Experimental	15	15	100.0
Science	12	10	83.3
Total	**27**	**25**	**93.6**

Following the completion of the online questionnaire, all 25 participants were contacted to conduct a follow-up interview. Teachers who indicated using at least parts of the Science-in-CTE science-enhanced lessons or pedagogical model received a personal follow-up interview, while teachers who had not used any of the lessons or model received a telephone interview. Results of the follow-up of teachers who completed personal and telephone interviews are listed in Table 2. Of the experimental CTE and science teachers who indicated using at least parts of the lessons, 20 of the 21 teachers (95%) received a personal follow-up interview, while three of the four teachers (75%) who did not teach any of the lessons participated in a telephone follow-up interview.

Of the experimental teachers, 12 (92%) were personally interviewed and two (100%) completed a telephone interview. One experimental teacher who completed a questionnaire opted out of the personal follow-up interview for personal reasons. Among the science teachers who completed the questionnaire, eight (100%) were personally interviewed and one (50%)

completed a telephone interview. One science teacher who completed an online questionnaire opted out of the telephone follow-up interview for personal reasons.

Table 2.

Follow-up Personal and Telephone Interviews Completed with Experimental CTE and Science Teachers who Completed Online Questionnaires

	Online questionnaires completed	Interviews conducted	% Interviews conducted
Personal interviews			
CTE Experimental	13	12	92.3
Science	8	8	100.0
Total	**21**	**20**	**95.2**
Telephone interviews			
CTE Experimental	2	2	100.0
Science	2	1	50.0
Total	**4**	**3**	**75.0**

Research Question 1 Analysis

For the first research question, data analysis was conducted to determine the extent to which experimental CTE teachers who participated in the North Dakota Pilot Study continued to use the pedagogical model and specific lessons that had been developed for the study after the experiment ended. Experimental CTE teachers' use of Science-in-CTE lessons and the pedagogical model are stated in Table 3.

Thirteen (87%) of the 15 experimental teachers reported the inclusion of explicit science instruction that was designed to teach the concepts inherent within their secondary Agricultural Education courses. The remaining two teachers (13%) did not teach secondary Agricultural Education courses during the 2010-2011 school year due to a change in careers. Of the 13

experimental teachers who taught explicit science, 12 (92%) used a combination of Science-in-CTE materials that included the science-enhanced lessons and the pedagogical model.

Table 3.

Use of Science-in-CTE Method or Materials During 2010-2011 School Year by Experimental CTE Teachers Who Responded to the Questionnaire (N = 15)

Use of method or lessons	*n*	%
Taught explicit science	13	86.7
Used Science-in-CTE method and lessons	12	92.3
Used other methods	8	61.5
Did not teach CTE courses	2	13.3

Note. Total exceeds 100% based on teachers' option to select multiple responses.

However, experimental teachers also indicated having used other methods to teach explicit science. One teacher (8%) included the 5E (Engage, Explore, Explain, Elaboration, and Evaluate) Instructional Model as a method of teaching science. State-developed/approved materials were selected by 23% of the teachers, while 31% of the experimental teachers also indicated using district/school-specific materials.

Data were further analyzed to determine the extent experimental teachers used the specific science-enhanced lessons. Experimental CTE and science teacher partners developed 15 CTE science-enhanced lessons for the Science-in-CTE Pilot Study. These lessons focused on CTE plant sciences. A breakout of lessons and usage by experimental CTE teacher respondents is listed in Table 4.

Experimental CTE teachers listed the Science-in-CTE lessons they taught during the 2010-2011 school year. Eleven respondents (92%) indicated they taught Lesson 1 on roots in their secondary Agricultural Education courses. Continuing with the curriculum, 10 experimental CTE teachers (83%) each taught Lesson 2 that focused on stems and Lesson 3 detailed leaves. Lesson 4 focused on photosynthesis and 10 teachers (83%) responded they had

taught the lesson. Eleven teachers (92%) each taught Lesson 5 on flowers and Lesson 6 on sexual reproduction.

Table 4.

Science-Enhanced Lessons Taught During 2010-2011 by Experimental CTE Teachers Who Used the Science-in-CTE Method and Lessons (N = 12)

Science-enhanced lesson	*n*	%
Lesson 1. Roots	11	91.7
Lesson 2. Stems	10	83.3
Lesson 3. Leaves	10	83.3
Lesson 4. Photosynthesis	10	83.3
Lesson 5. Flowers	11	91.7
Lesson 6. Sexual Reproduction	11	91.7
Lesson 7. Asexual Reproduction	9	75.0
Lesson 8. Genetically Modified Organisms	6	50.0
Lesson 9. Seeds	11	91.7
Lesson 10. Germination	11	91.7
Lesson 11. Data Collection	7	58.3
Lesson 12. Elements of Growth	8	66.7
Lesson 13. Nutrients	10	83.3
Lesson 14. Soil Texture	8	66.7
Lesson 15. Biofuels	7	58.3

Lesson 7 was about asexual reproduction. It did not have nearly identical results to Lesson 6, but nine teachers (75%) reported teaching the lesson. Lesson 8 dealt with genetically modified organisms. Responses were lower for Lesson 8 as only six respondents (50%) reported they taught the lesson. Contrary to Lesson 8's low inclusion rate, the respondent rates increased on Lesson 9 regarding seeds where 11 experimental CTE teachers (92%) reported they taught the lesson. Lesson 10 sprouted into a lesson on germination that 11 teachers (85%) taught.

Lesson 11 dealt with data collection and seven CTE teachers (58%) included Lesson 11 in their CTE curricula. The next two lessons provided supplement to the CTE curricula as Lesson 12 contained the elements needed for growth and Lesson 13 featured nutrients. Eight respondents (67%) taught Lesson 12 and 10 (83%) taught Lesson 13. Teachers dug into soil

texture in Lesson 14 as eight experimental CTE teachers (67%) taught the lesson. Rounding out the set of 15 Science-in-CTE plant sciences lessons, Lesson 15 consisted of biofuels. Seven experimental CTE teachers (58%) incorporated this science-enhanced lesson into their CTE curricula.

Aside from the science-enhanced lessons, another component of the Science-in-CTE Pilot Study was the use of the seven-element pedagogical model. To help determine the extent that the model was used, data were analyzed from experimental CTE teachers who responded to the questionnaire. Teachers were asked if they adopted any part of the seven-element model or none. A breakdown of each element and the teachers' responses are listed in Table 5.

A majority of experimental CTE teachers adopted each element within the CTE pedagogical model. Element 1 was designed to introduce the CTE lesson. Of the experimental CTE teacher respondents, nine teachers (90%) adopted Element 1. Element 2 assessed the students' science awareness as it related to the CTE lesson. Seven (70%) of ten respondents had adopted Element 2 into their instruction. Science concepts and principles naturally exist in Career and Technical Education curricula. Element 3 was designed for teachers to work through the science that is naturally embedded in the agricultural lesson and to apply it. Nine CTE teachers (90%) recognized this element and adopted it. Next, Element 4 was designed for CTE teachers to work through related, contextual examples of science within the CTE content. Nine experimental CTE teachers (90%) adopted Element 4. Eight of the experimental CTE teachers (80%) worked through the explicit science examples in their lessons. Element 5 guided teachers to use explicit science examples that could be found in science curricula or on standardized science tests. Elements 3, 4, and 5 focused on finding the commonalities among CTE and science vocabulary. In Element 6, students demonstrated their understanding of science concepts

Table 5.

Adoption of Seven-Element Pedagogical Model by Experimental CTE and Science Teacher Respondents

	Experimental CTE[a]				Science[b]			
	Adopted		Not adopted		Adopted		Not adopted	
Elements of model	*n*	%	*n*	%	*n*	%	*n*	%
Element 1. Introduce the lesson	9	90.0	1	10.0	4	100.0	0	0.0
Element 2. Assess students' science awareness as it relates to the agricultural application	7	70.0	3	30.0	2	50.0	2	50.0
Element 3. Work through the science embedded in the agricultural application	9	90.0	1	10.0	2	50.0	2	50.0
Element 4. Work through related, contextual examples	9	90.0	0	0.0	3	75.0	1	25.0
Element 5. Work through explicit science examples	8	80.0	2	20.0	3	75.0	1	25.0
Element 6. Students demonstrate their understanding	10	100.0	0	0.0	4	100.0	0	0.0
Element 7. Formal assessment	10	100.0	0	0.0	4	100.0	0	0.0

[a]*N* = 10. Of the 12 experimental CTE teachers who used the Science-in-CTE methods and lessons, two teachers indicated that they used the lessons and not the method.
[b]*N* = 4.

embedded in the CTE lesson. Students were formally assessed with science questions incorporated into their CTE assessment in Element 7. Of the 10 experimental CTE teachers who responded to the questionnaire, 100% adopted Elements 6 and 7.

Research Question 2 Analysis

For the second research question, data analysis was conducted to determine the extent to which science teachers who worked with the experimental CTE teachers used the pedagogical model or any of the occupational examples from the lessons that were developed in their academic classes. Science teachers' uses of the pedagogical model or occupational examples from the CTE lessons are stated in Table 6.

Table 6.

Use of Science-in-CTE Method or Materials During 2010-2011 School Year by Science Teachers Who Responded to the Questionnaire (N =10)

Use of method or lessons	*n*	%
Used Science-in-CTE method or examples	8	80.0
Used the model	4	50.0
Used agricultural examples from lessons	8	100.0
Did not use method or examples	2	20.0

Note. Total exceeds 100% based on teachers' option to select multiple responses.

Ten science teachers completed the questionnaire and all taught science courses during the 2010-2011 school year. Of the science teachers who responded, two science teachers (20%) indicated they taught science during the 2010-2011 school year, but did not include any of the methods or examples from the lessons developed for the Science-in-CTE study in their classroom. However, eight (80%) of the 10 respondents used methods or examples from the lessons developed for the Science-in-CTE Pilot Study in their science classes. Of the eight science teachers, 100% stated they used specific agricultural examples from the lessons.

Four (50%) of the eight science teachers who used methods or examples from the Science-in-CTE lessons indicated that they specifically used elements of the Science-in-CTE pedagogical model. Data were analyzed to determine the extent the model was used by the science teachers. The seven-element model was the same model described in the previous section for the experimental CTE teachers and a breakdown of each element and the teachers' responses are listed in Table 5.

Teachers were asked if they adopted any part of the seven-element model. Of the four science teachers who used the model, all (100%) teachers adopted Elements 1, 6, and 7 into their instruction. Elements 2 and 3 were adopted by half (50%) of the teachers. One science teacher made a slight modification to Element 3 and the students worked through the agriculture embedded within the science. The remaining two elements, Elements 4 and 5, were adopted by three (75%) of the four science teachers.

Research Question 3 Analysis

For the third research question, data analysis was conducted to determine the extent experimental CTE teachers believed their students' CTE course achievement was enhanced after using the lessons developed for the Pilot Study. Of the 13 experimental CTE teachers who completed the questionnaire, none believed their students' course achievement was slightly enhanced or not enhanced at all. Three teachers (23%) believed their students experienced a somewhat enhanced course achievement after using science-enhanced lessons. However, a majority of teachers (61%) felt that student course achievement was moderately enhanced when science-enhanced lessons were used in their CTE curricula. The remaining two experimental

CTE teachers believed their students' course achievement was greatly enhanced after using science-enhanced lessons. Results for this data analysis are described in Table 7.

Table 7.

Experimental CTE Teachers' Ratings of Extent Students' Course Achievement was Enhanced After Using Science-Enhanced Lessons (N = 13)

Ratings of Extent Instruction Enhanced	*n*	%
Greatly enhanced	2	15.4
Moderately enhanced	8	61.5
Somewhat enhanced	3	23.1
Slightly enhanced	0	0.0
Not enhanced	0	0.0

Research Question 4 Analysis

For the fourth research question, data analysis was conducted to determine the extent experimental CTE teachers believed their CTE curricula was reduced with the implementation of the enhanced science concepts. The same 13 experimental CTE teachers who reported on the extent their students' course achievement was enhanced, also reported the extent they believed their CTE curricula was reduced after the science-enhanced concepts were implemented. Results are listed in Table 8.

None of the experimental CTE teachers believed their CTE curricula was greatly reduced when enhanced science concepts were incorporated into their curricula. A majority (54%) of the teachers, however, believed their CTE curricula had no change when the enhanced science concepts were implemented. Among the experimental CTE teachers, two teachers (15%) believed their CTE curricula was slightly reduced and two additional teachers believed it was somewhat reduced. Likewise, two CTE teachers (15%) believed their curricula was moderately reduced with the implementation of enhanced science concepts.

Table 8.

Experimental CTE Teachers' Rating of Extent CTE Curricula was Reduced with Implementation of Enhanced Science Concepts (N = 13)

Ratings of Extent Curricula Reduced	*n*	%
Greatly reduced	0	0.0
Moderately reduced	2	15.4
Somewhat reduced	2	15.4
Slightly reduced	2	15.4
No change	7	53.8

Summary of the Chapter

Online questionnaires were completed by 100% of the experimental CTE teachers and over 80% of the science teachers. Based on the questionnaire responses, there was a completion rate of 95% for personal follow-up interviews and a 75% completion rate for telephone interviews. Ninety-two percent of the experimental CTE and 80% of the science teachers used methods or materials from the Science-in-CTE Pilot Study during the 2010-2011 school year. Over 80% of the CTE teachers used nine of the 15 science-enhanced lessons a year following the Pilot Study. Ninety percent of the experimental CTE teachers adopted at least five of the seven elements in the pedagogical model and 100% of the science teachers adopted three elements of the model into their classroom instruction. After using the science-enhanced lessons, 62% of the CTE teachers believed their students' course achievement was moderately enhanced. However, 54% of CTE teachers believed their CTE curricula remained the same after implementation of the enhanced science concepts.

CHAPTER 5. DISCUSSION

The purpose of the research was to determine the sustainability of professional development among teachers who participated in the Science-in-CTE Pilot Study. Specifically, this follow-up study was developed to explore teacher utilization of the Science-in-CTE pedagogical model and Career and Technical Education (CTE) science-enhanced lessons in curricula one year following the Pilot Study.

To benefit secondary CTE and science teachers, the following research questions were raised:

1. To what extent would experimental CTE teachers who participated in the North Dakota Pilot Study continue to use the pedagogical model and specific lessons that had been developed for the study after the experiment ended?
2. To what extent are science teachers who worked with the CTE teachers using the pedagogical model or any of the occupational examples from the lessons developed in their academic classes?
3. To what extent do experimental CTE teachers believe their students' CTE course achievement was enhanced after using the lessons developed for the Pilot Study?
4. To what extent do experimental CTE teachers believe the CTE curricula was reduced with the implementation of the enhanced science concepts?

Teachers who participated in the 2009-2010 Science-in-CTE Pilot Study were invited to participate in the Science-in-CTE Follow-up Study. The follow-up study evaluated the teachers' use of the Science-in-CTE pedagogical model and science-enhanced CTE lessons one year after the completion of the Pilot Study. An online questionnaire was developed for the two groups of participants—experimental CTE and science teachers. Questions were modified from the Math-

in-CTE Follow-up Study. Teachers completed the questionnaires online via SurveyMonkey®. Of the respondents, teachers who indicated using at least a portion of the model or lessons were asked to participate in a personal follow-up interview. Respondents who did not use any of the components of the model or lessons were asked to complete a telephone follow-up interview.

Summary

The authorization of Perkins IV required CTE teachers to integrate core academic content into their CTE curricula. A growing concern for CTE teachers with the idea of integration is the amount of time and competency necessary to include academic content and the tipping point of integration over CTE content. Various studies showed that mathematic and science content could be integrated into CTE curricula without loosing the essence of the CTE content (Thompson, 1998; Warnick & Thompson, 2007; Parr et al., 2008; Myers et al., 2009; Young et al., 2009). In multiple cases, the students' CTE course achievement and academic content knowledge were both increased due to the integration. In order for successful integration to occur, quality professional developments will have to be provided for CTE and core academic teachers. Studies showed that traditional one-day, fragmented workshops would not be enough to sustain professional growth. This will mean a shift away from traditional professional development practices to those that focus on collaborative efforts, on-going or extended days, and build upon content and practices. Teachers will be asked to change their pedagogy and revise their curriculum. Understanding and utilizing the transtheoretical model of behavior change could lead to increased professional growth and increased student achievement for teachers and students in CTE programs and core academic content areas. If this strategy was used in the Science-in-CTE Pilot Study, how do we know if it was sustainable?

E-mail invitations were sent to 27 CTE and science teachers who participated in the Science-in-CTE Pilot Study. Online questionnaires were completed by all 15 of the experimental CTE teachers and 10 of the 12 science teachers. Of the 15 experimental CTE teachers who completed the online questionnaire, 13 teachers indicated they used methods or lessons from the Pilot Study a year after the study ended. Personal follow-up interviews were conducted with 92% of the CTE teachers. Of the remaining two CTE teachers who indicated they had not used methods or lessons from the Pilot Study, 100% of these teachers completed a telephone follow-up interview. Of the 10 science teachers who completed the online questionnaire, eight teachers indicated they used methods or lessons from the Pilot Study. One hundred percent of these teachers completed a personal follow-up interview. Of the two remaining science teachers who indicated they had not used methods or lessons from the Pilot Study, 50% of the teachers completed a telephone follow-up interview. Overall, 92% of the experimental CTE and 80% of the science teachers used methods or materials from the Science-in-CTE Pilot Study during the 2010-2011 school year. Over 80% of the CTE teachers used at least nine of the 15 science-enhanced lessons a year following the Pilot Study. Ninety percent of the experimental CTE teachers adopted at least five of the seven elements in the pedagogical model and 100% of the science teachers adopted at least three elements of the model into their classroom instruction. After using the science-enhanced lessons, 62% of the CTE teachers believed their students' course achievement was moderately enhanced, but 54% of CTE teachers believed their CTE curricula remained the same after implementation of the enhanced science concepts.

Conclusions

E-mail invitations were sent to 15 experimental CTE and 10 science teachers who participated in the Science-in-CTE Pilot Study. All fifteen of the experimental CTE teachers and 10 of the 12 science teachers completed online questionnaires. Teachers dealt with some critical limitations during the follow-up study such as end-of-the-year responsibilities, summer break, and a natural disaster. However, the high response rate was not surprising since the researcher worked closely with both groups during the Science-in-CTE Pilot Study during 2009-2010. It was assumed that the personal association that was established during the Pilot Study continued into the following year when follow-up data were collected. Likewise, the completion rate for the follow-up interviews was high. All but one of the experimental CTE teachers completed a personal follow-up interview and all of them completed telephone interviews. All science teachers completed personal follow-up interviews and only one teacher did not complete the telephone interview. While intrinsic motivation seemed to have positive results, one cannot forget that an extrinsic motivator—monetary honorarium—was used. Teachers who completed the online questionnaire received a $50 honorarium and an additional $50 honorarium was given to participants who completed a personal follow-up interview.

Research Question 1. The first research question determined the extent to which experimental CTE teachers who participated in the North Dakota Pilot Study continued to use the pedagogical model and specific lessons that were developed for the study after the experiment ended. Of the 13 experimental CTE teachers who taught explicit science in their CTE course, 12 teachers used the Science-in-CTE method and lessons. Nearly half of the experimental CTE teachers taught three-quarters of the lesson developed from the Pilot Study and three-quarters of the teachers taught over half of the lessons. Ten of the 15 lessons' topics

could be found in most traditional production agriculture curricula. With the exception of Lesson 12 on the elements of growth, the other nine production-oriented lessons were taught by at least 10 of the 12 experimental CTE teachers.

Three-quarters of the experimental CTE teachers adopted at least three-quarters of the seven-element pedagogical model in the lessons they taught. Almost all of the experimental CTE teachers recognized the value for students to demonstrate their understanding (Element 6) and to conduct a formal assessment (Element 7) and adopted both elements. There may have been some ambiguity as to the level or method of adoption as two teachers indicated they taught all the science-enhanced lessons, but did not adopt the seven-element pedagogical model. Assessing the students' science awareness in Element 2 was the least adopted by experimental CTE teachers. However, seven of the 10 teachers still adopted Element 2 into their teaching approach.

Research Question 2. The second research question determined the extent to which science teachers who worked with the experimental CTE teachers used the pedagogical model or any of the occupational examples from the lessons that were developed in their academic classes. A majority of the science teachers used methods or materials from the Science-in-CTE Pilot Study during the 2010-2011 school year. Of these, all of the science teachers used agricultural examples from the lessons, but only half of them used the model.

Of the four science teachers who used the seven-element model, all of them adopted three elements. At least three of the teachers adopted a minimum of five of the seven elements. Elements 2 and 3 were the least adopted by science teachers. Similar to the experimental CTE teachers, science teachers recognized the values of Elements 6 and 7 for students to demonstrate their understanding and to conduct an assessment.

Research Question 3. The third research question determined the extent experimental CTE teachers believed their students' CTE course achievement was enhanced after using the lessons developed for the Pilot Study. Overall, the experimental CTE teachers felt their students' course achievement was at least somewhat enhanced after using science-enhanced lessons. Nearly three-quarters of the teachers felt the course achievement was moderately or greatly enhanced.

Research Question 4. The fourth research question determined the extent experimental CTE teachers believed their CTE curricula was reduced with the implementation of the enhanced science concepts. After using the science-enhanced lessons, half of the experimental CTE teachers believed their CTE curricula received no change after implementation of the enhanced science concepts. The other half of the teachers equally believed their curricula was slightly, somewhat, or moderately reduced with the implementation of the science concepts.

Implications of the Findings

As a partial replication of the Math-in-CTE Follow-up Study, the Science-in-CTE Follow-up Study showed that the professional development model is sustainable. The model combined professional development and pedagogy. The number of experimental CTE teachers who continued to use the methods and lessons one year after the Pilot Study concluded was consistent with those reported in the Math-in-CTE Follow-up Study (Lewis & Pearson, 2007, pg. 14, Table 3). There was also consistency in the number of science teachers who used the model and agricultural examples from the lessons as compared to the math teachers from the Math-in-CTE Follow-up Study (Lewis & Pearson, 2007, pg. 18, Table 7). Based on the high percentage of lessons that were taught by experimental CTE teachers one year after the study ended, one

could presume that teachers will continue to use agricultural lessons and materials that had been developed and enhanced with a science partner, then peer-reviewed and taught. Two experimental CTE teachers described the professional development as,

> Being a part of the study made it a lot easier for me to teach those things the standards now say we're going to have to teach and, probably most importantly, it gives me confidence to teach some things I'm not as comfortable with—having an approach to those things that 'this is how you should teach it' and not just pulling things out of a book and putting notes on a PowerPoint.

> It [professional development] probably needs to happen if you're doing set-up lessons like this because it really helps everyone get an idea of what's going on.

Overall, the type of professional development offered in the Math-in-CTE and Science-in-CTE studies are different than traditional professional developments. The process used in this model allows for teachers to move from professional development and into technical assistance.

Some minor adjustments could be applied to the pedagogical model. While teachers adopted the various elements at different rates, it was evident that the teachers recognized the importance of anticipatory set, demonstration of knowledge, and commitment to assessment. However, the weakest link for experimental CTE teachers was Element 2—assessing the students' science awareness as it related to the agricultural application. A clarification and deeper understanding of the intent of this element may aid the adoption rate. Interestingly enough, experimental CTE teachers were more likely to work through the science embedded in the agricultural application (Element 3) than to assess the students' science awareness as it related to the agricultural application (Element 2).

Experimental CTE teachers recognized an improvement in their students' achievement. However, the teachers felt their CTE curricula was not enhanced nor reduced. CTE teachers often cited time as a reason they did not use parts of the model or the science-enhanced lessons.

One experimental CTE teacher explained why they did not use the model, “It’s a time factor! I can’t imagine doing this for every lesson. If so, I might as well move a bed in there [school] because I’d be there forever.” However, this same instructor also explained how their participation in the study impacted their approach to CTE instruction. “It made me a little more science aware. Ag and science are intertwined and it reminds me that we [Agricultural Education] are reinforcing these science concepts that these kids are learning, too, and that’s hopefully making them a better student.”

Recommendations for Further Research

Data from this study suggests that further research should be conducted on the following:

1. Would similar results be found if CTE and science teachers implemented the Science-in-CTE methods and model, but were not monitored within the confines of an experimental research design study? Would the methods and model be sustainable strictly as a professional development? Much effort was made during the Science-in-CTE Pilot Study to maintain the fidelity of the treatment—lesson scope and sequence was established and monitored throughout the study, artifacts of student work were collected from the science-enhanced lessons, and pre- and post- teaching reports were collected from teachers.
2. Is the Science-in-CTE model adaptable to other Agricultural Education instructional units or topics?
3. Is the Science-in-CTE model adaptable to other CTE content areas?

4. Is the Science-in-CTE model sustainable over time? Would teachers continue to utilize the model two years following the professional development? Five years? Ten years?
5. Would teachers benefit from a periodic "refresher" professional development? If so, how soon following a professional development?
6. Would CTE teachers be more apt to collaborate with teachers in other content areas to develop content-enhanced CTE lessons? Would teachers from other content areas take the initiative to collaborate with CTE teachers to develop CTE-enhanced lessons to be used in their specific content area?
7. Would core academic teachers implement CTE examples into their curricula to improve their students' course achievement and/or scores on standardized tests? Would the implementation of CTE examples improve students' course achievement or standardized test scores?
8. What factors influence CTE teachers' ability to adapt to change in regards to adopting the Science-in-CTE pedagogical model and lessons?
9. To what extent would CTE teachers who participated in the Science-in-CTE Pilot Study control group use the science-enhanced lessons following traditional professional development? To what extent would control CTE teachers continue to use the pedagogical model from the Science-in-CTE Pilot Study?
10. To what extent did teachers who participated in the Science-in-CTE Pilot Study modify or change the science-enhanced lessons?

Overall Conclusion

The primary conclusion drawn from this study was that, in this particular sample of North Dakota Agricultural Education and science teachers, the pedagogical model and science-enhanced lessons developed were still being utilized one year after the Science-in-CTE professional development. Teachers voluntarily incorporated the model and lessons into their own programs without the parameters and technical support from the experimental research study. Experimental CTE and science teachers perceived that the professional development was effective in producing collaborations among teacher partners and content areas. The experimental CTE teachers' perceptions were that development and utilization of the science-enhanced lessons increased student achievement.

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APPENDIX A. INSTITUTIONAL REVIEW BOARD APPROVAL

NDSU NORTH DAKOTA STATE UNIVERSITY

Institutional Review Board
Office of the Vice President for Research, Creative Activities and Technology Transfer
NDSU Dept. 4000
1735 NDSU Research Park Drive
Research 1, P.O. Box 6050
Fargo, ND 58108-6050

701.231.8995
Fax 701.231.8098
Federalwide Assurance #FWA00002439

Monday, May 16, 2011

Dr. R. Brent Young
School of Education - Teacher Education, Agricultural Development Paradigm
155 EML

Re: IRB Certification of Human Research Project:

"Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm"
Protocol **#HE11282**

Co-investigator(s) and research team: **Wendi M. Mizer Stachler, Mari Borr**

Study site(s): **NDSU** Funding: **ND Dept. of Career and Technical Education (pending)**

It has been determined that this human subjects research project qualifies for exempt status (category # 2) in accordance with federal regulations (Code of Federal Regulations, Title 45, Part 46, *Protection of Human Subjects*). This determination is based on the protocol form received 5/13/2011 and consent/information sheet received 5/13/2011.

Please also note the following:

- This determination of exemption expires 3 years from this date. If you wish to continue the research after 5/15/2014, the IRB must re-certify the protocol prior to this date.
- The project must be conducted as described in the approved protocol. If you wish to make changes, pre-approval is to be obtained from the IRB, unless the changes are necessary to eliminate an apparent immediate hazard to subjects. A *Protocol Amendment Request Form* is available on the IRB website.
- Prompt, written notification must be made to the IRB of any adverse events, complaints, or unanticipated problems involving risks to subjects or others related to this project.
- Any significant new findings that may affect the risks and benefits to participation will be reported in writing to the participants and the IRB.
- Research records may be subject to a random or directed audit at any time to verify compliance with IRB policies.

Thank you for complying with NDSU IRB procedures; best wishes for success with your project.

Sincerely,

[redacted]

Kristy Shirley, CIP, Research Compliance Administrator

APPENDIX B. INVITATION TO PARTICIPATE—EXPERIMENTAL AND CONTROL CTE TEACHERS

E-MAIL INVITE TO PARTICIPATE
EXPERIMENTAL & CONTROL AG ED TEACHERS

Dear _____,

Thank you for participating in the North Dakota Science-in-CTE Pilot Study. With the positive outcome of that study, I would like to invite you to participate in a brief on-line questionnaire.

The purpose of this follow-up study is to determine if the professional development model is sustainable in Agricultural Education. The questionnaire should only take about 20 minutes to complete. All responses will remain strictly confidential. If you choose to complete the on-line questionnaire, you will receive a $50 Wal-mart Gift Card as a token of our appreciation.

Attached is an Informed Consent form that you can read to learn more about the study and your rights as a participant. You may click on the link below and it will take you directly to the on-line questionnaire.

_____(insert questionnaire link here)_____

Thank you for your consideration. Your participation in this study is completely voluntary. I enjoyed working with you on the Pilot Study and I look forward to hopefully working with you again on this follow-up study. If you have any questions, please feel free to contact Dr. Young (brent.young@ndsu.edu) or myself (wendi.m.stachler@ndsu.edu).

Sincerely,
Wendi M. Mizer Stachler & Dr. Young

****

Mrs. Wendi M. Mizer Stachler
North Dakota State University, School of Education
Graduate Teaching Associate, Agricultural & Extension Education
Graduate Research Assistant, Science-in-CTE
NDSU Dept #2625, PO Box 6050
Fargo, ND 58108-6050

Cell: [redacted]
Home: [redacted]
Wendi.M.Stachler@ndsu.edu

APPENDIX C. INVITATION TO PARTICIPATE—SCIENCE TEACHERS

E-MAIL INVITE TO PARTICIPATE
EXPERIMENTAL SCIENCE TEACHERS

Dear _____,

Thank you for participating in the North Dakota Science-in-CTE Pilot Study. With the positive outcome of that study, I would like to invite you to participate in a brief on-line questionnaire.

The purpose of this follow-up study is to determine if the professional development model is sustainable in Science courses. The questionnaire should only take about 20 minutes to complete. All responses will remain strictly confidential. If you choose to complete the on-line questionnaire, you will receive a $50 Wal-mart Gift Card as a token of our appreciation.

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_____(insert questionnaire link here)_____

Thank you for your consideration. Your participation in this study is completely voluntary. I enjoyed working with you on the Pilot Study and I look forward to hopefully working with you again on this follow-up study. If you have any questions, please feel free to contact Dr. Young (brent.young@ndsu.edu) or myself (wendi.m.stachler@ndsu.edu).

Sincerely,
Wendi M. Mizer Stachler & Dr. Young

****

Mrs. Wendi M. Mizer Stachler
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Graduate Research Assistant, Science-in-CTE
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APPENDIX D. QUESTIONNAIRE INFORMED CONSENT—EXPERIMENTAL CTE TEACHERS

NDSU NORTH DAKOTA STATE UNIVERSITY

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Fargo, ND 58108-6050

Administrative Offices
210 Family Life Center
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Fax 701-231-7416
www.ndsu.edu/ndsu/education

May 26, 2011

Dear Science-in-CTE Pilot Study Participant:

The Agricultural and Extension Education program in NDSU's School of Education in the College of Human Development and Education invites you to participate in a follow-up study to the Science-in-CTE Pilot study you participated in during the 2009-2010 school year. Please read this form and ask any questions you may have before agreeing to continue in the study.

Background Information:
The purpose of this study is to determine if the professional development model is sustainable in Agricultural Education and Science. This involves a new method of obtaining quality professional development and a new way of teaching science in the regular Agricultural Education and Science curricula.

Project Title:
Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm

Investigators:
Dr. R. Brent Young, Principal Investigator
Mrs. Wendi M. Mizer Stachler, Co-Investigator

Procedures:
If you agree to participate in this study, you will agree to do the following:

- Complete an on-line questionnaire about your use of explicit science instruction in your secondary Agricultural Education and/or Science courses
- Participate in a telephone or personal interview following the questionnaire

Risks and Benefits of Participation:
This study will test if explicit science instruction in Agricultural Education courses is sustainable for secondary Agricultural Education teachers. It will test if the methods or examples developed in the Pilot Study are sustainable for secondary Science teachers. If the Pilot Study's procedures were successful, you have been a more effective teacher and your students have increased their understanding of science concepts and their applications.

You will receive a $50 stipend for completing the on-line questionnaire. Participants who are selected to participate in and complete a personal interview will receive an additional $50 stipend.

Confidentiality:
The records of this study will be kept private. Personal and telephone interviews will be audio taped and transcribed. As names will be initially included on the on-line survey, the raw data will not be anonymous. Confidentiality, however, will be promised in any report or publication. We will keep your name and data, as well as those of your students and school, completely anonymous and confidential. In any report we might publish, we will not include any individual information that will make it possible to identify a subject.

The Co-Investigator will keep all the data and audio-tapes in a secure location for three years after the conclusion of the study. At which time, the material will be destroyed.

Voluntary Nature of the Study:
Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with North Dakota State University. If you decide to participate, you are free to withdraw at any time, but you will not receive the stipend for the portion(s) you did not complete (i.e. on-line questionnaire, telephone interview, or personal interview).

Contacts and Questions:
If you have any questions about this study, you may contact the Principal Investigator, Dr. R. Brent Young, Assistant Professor, at Brent.Young@ndsu.edu, phone: 701/231-7439; or the Co-Investigator, Mrs. Wendi M. Mizer Stachler, Graduate Student, at Wendi.M.Stachler@ndsu.edu, phone: [redacted]. They will be serving as the researchers for this study.

If you have any questions or concerns regarding the rights of research participants or to report a complaint about this research, contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu, phone: 701/231-8908.

Statement of Consent:
I have read the above information. I have asked questions and have received answers. By clicking on the link below, I consent to participate in the study. I understand that the on-line questionnaire may take 20 minutes to complete and I am aware that I may be contacted and asked to participate in a telephone or personal follow-up interview.

http://www.surveymonkey.com/s/ExperimentalFollowUp

APPENDIX E. QUESTIONNAIRE INFORMED CONSENT—SCIENCE TEACHERS

NDSU NORTH DAKOTA STATE UNIVERSITY

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210 Family Life Center
701-231-7921
Fax 701-231-7416
www.ndsu.edu/ndsu/education

May 26, 2011

Dear Science-in-CTE Pilot Study Participant:

The Agricultural and Extension Education program in NDSU's School of Education in the College of Human Development and Education invites you to participate in a follow-up study to the Science-in-CTE Pilot study you participated in during the 2009-2010 school year. Please read this form and ask any questions you may have before agreeing to continue in the study.

Background Information:
The purpose of this study is to determine if the professional development model is sustainable in Agricultural Education and Science. This involves a new method of obtaining quality professional development and a new way of teaching science in the regular Agricultural Education and Science curricula.

Project Title:
Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm

Investigators:
Dr. R. Brent Young, Principal Investigator
Mrs. Wendi M. Mizer Stachler, Co-Investigator

Procedures:
If you agree to participate in this study, you will agree to do the following:

- Complete an on-line questionnaire about your use of explicit science instruction in your secondary Agricultural Education and/or Science courses
- Participate in a telephone or personal interview following the questionnaire

Risks and Benefits of Participation:
This study will test if explicit science instruction in Agricultural Education courses is sustainable for secondary Agricultural Education teachers. It will test if the methods or examples developed in the Pilot Study are sustainable for secondary Science teachers. If the Pilot Study's procedures were successful, you have been a more effective teacher and your students have increased their understanding of science concepts and their applications.

You will receive a $50 stipend for completing the on-line questionnaire. Participants who are selected to participate in and complete a personal interview will receive an additional $50 stipend.

Confidentiality:
The records of this study will be kept private. Personal and telephone interviews will be audio taped and transcribed. As names will be initially included on the on-line survey, the raw data will not be anonymous. Confidentiality, however, will be promised in any report or publication. We will keep your name and data, as well as those of your students and school, completely anonymous and confidential. In any report we might publish, we will not include any individual information that will make it possible to identify a subject.

The Co-Investigator will keep all the data and audio-tapes in a secure location for three years after the conclusion of the study. At which time, the material will be destroyed.

Voluntary Nature of the Study:
Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with North Dakota State University. If you decide to participate, you are free to withdraw at any time, but you will not receive the stipend for the portion(s) you did not complete (i.e. on-line questionnaire, telephone interview, or personal interview).

Contacts and Questions:
If you have any questions about this study, you may contact the Principal Investigator, Dr. R. Brent Young, Assistant Professor, at Brent.Young@ndsu.edu, phone: 701/231-7439; or the Co-Investigator, Mrs. Wendi M. Mizer Stachler, Graduate Student, at Wendi.M.Stachler@ndsu.edu, phone: [redacted]. They will be serving as the researchers for this study.

If you have any questions or concerns regarding the rights of research participants or to report a complaint about this research, contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu, phone: 701/231-8908.

Statement of Consent:
I have read the above information. I have asked questions and have received answers. By clicking on the link below, I consent to participate in the study. I understand that the on-line questionnaire may take 20 minutes to complete and I am aware that I may be contacted and asked to participate in a telephone or personal follow-up interview.

http://www.surveymonkey.com/s/ControlFollowUp

APPENDIX F. ONLINE QUESTIONNAIRE—CTE EXPERIMENTAL TEACHERS

ND Science in CTE Experimental Ag Teacher Follow Up

Informed Consent

Dear Science-in-CTE Pilot Study Participant:

The Agricultural and Extension Education program in NDSUs School of Education in the College of Human Development and Education invites you to participate in a follow-up study to the Science-in-CTE study you participated in during the 2009-2010 school year. Please read this form and ask any questions you may have before agreeing to continue in the study.

Background Information:
The purpose of this study is to determine if the professional development model is sustainable in Agricultural Education and Science. This involves a new method of obtaining quality professional development and a new way of teaching science in the regular Agricultural Education and Science curricula.

Project Title:
Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm

Investigators:
Dr. R. Brent Young, Principal Investigator
Mrs. Wendi M. Mizer Stachler, Co-Investigator

Procedures:
If you agree to participate in this study, you will agree to do the following:
- Complete an on-line questionnaire about your use of explicit science instruction in your secondary Agricultural Education and/or Science courses
- Participate in a telephone or personal interview following the questionnaire

Risks and Benefits of Participation:
This study will test if explicit science instruction in Agricultural Education courses is sustainable for secondary Agricultural Education teachers. It will test if the methods or examples developed in the Pilot Study are sustainable for secondary Science teachers. If the Pilot Study's procedures were successful, you have been a more effective teacher and your students have increased their understanding of science concepts and their applications.

You will receive a $50 stipend for completing the on-line questionnaire. Participants who are selected to participate in and complete a personal interview will receive an additional $50 Wal-mart Gift Card.

Confidentiality:
The records of this study will be kept private. Personal and telephone interviews will be audio taped and transcribed. As names will be initially included on the on-line survey, the raw data will not be anonymous. Confidentiality, however, will be promised in any report or publication. We will keep your name and data, as well as those of your students and school, completely anonymous and confidential. In any report we might publish, we will not include any individual information that will make it possible to identify a subject.

The co-Investigator will keep all the data and audio-tapes in a secure location for three years after the conclusion of the study. At which time, the material will be destroyed.

Voluntary Nature of the Study:
Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with North Dakota State University. If you decide to participate, you are free to withdraw at any time, but you will not receive the gift card for the portion (s) you did not complete (i.e. on-line questionnaire, telephone interview, or personal interview).

Contacts and Questions:
If you have any questions about this study, you may contact the Principal Investigator, Dr. R. Brent Young, Assistant Professor, at Brent.Young@ndsu.edu, phone: 701/231-7439; or the co-Investigator, Mrs. Wendi M. Mizer Stachler, Graduate Student, at Wendi.M.Stachler@ndsu.edu, phone: [redacted]. They will be serving as the researchers for this study.

ND Science in CTE Experimental Ag Teacher Follow Up

If you have any questions or concerns regarding the rights of research participants or to report a complaint about this research, contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu, phone: 701/231-8908.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. By clicking on the link below, I consent to participate.

***Do you accept?**

◯ Yes

◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

Control Ag Teachers

We appreciate your willingness to assist us with this follow-up survey. Please select your responses to the questions below. If marking 'other,' a box will be provided for you to clarify your answer. Thank you.

Please type your first and last name. This information will be used only to identify who to contact for follow-up interviews. Your name will then be changed to a number.

***Have you taught secondary Agricultural Education courses this school year (fall 2010 through spring 2011)?**

- ◯ Yes
- ◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

Included Explicit Science

***Have you included any explicit science instruction that was designed to teach the concepts inherent within these secondary Agricultural Education courses? Explicit science instruction means going beyond specific agricultural applications to explain the general science concepts that underlie the applications.**

- ◯ Yes
- ◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

A Science Approach

What approach have you used to teach the science? (Please check all that apply.)

- ☐ 7-element approach that was tested in the Science-in-CTE Study
- ☐ CASE (Curriculum for Agricultural Science Education) materials
- ☐ BSCS (Biological Science Curriculum Study) materials
- ☐ FOSS (Full Option Science System) materials
- ☐ 5E (Engage, Explore, Explain, Elaboration, and Evaluate) instructional model
- ☐ State-developed/approved materials
- ☐ District/school specific materials

Other (please describe)

Why are you continuing to explicitly teach science in your courses? (Please check all that apply.)

- ☐ I recognize the value of this approach
- ☐ I have the knowledge/confidence to teach science
- ☐ Science instruction improves my courses, better prepares students for jobs
- ☐ School/district requires science instruction in all courses

Other (please describe)

***During the current school year, do you have any contact with the science instructor with whom you worked during the study or a different science instructor to review the teaching of science concepts?**

- ○ No contact with science instructors to review teaching of science
- ○ Contact with instructor with whom I worked
- ○ Contact with different science instructor
- ○ Contact with instructor with whom I worked and different science instructor(s)

ND Science in CTE Experimental Ag Teacher Follow Up

A3why No contact

Why didn't you have contact with science instructor(s)?

ND Science in CTE Experimental Ag Teacher Follow Up

A3a Contact Frequency

If you have any contacts with science teachers, how frequent are they?

- ◯ Less than once a month
- ◯ Once a month
- ◯ Once every two or three weeks
- ◯ About once a week
- ◯ Almost every day

ND Science in CTE Experimental Ag Teacher Follow Up

A4 Lessons Taught

***Have you taught or do you plan to teach any of the science-enhanced lessons or parts of the lessons that were developed for the Science-in-CTE study?**

- ◯ Yes
- ◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

A4a Lessons Taught List

Which lesson(s) have you taught and which lesson(s) do you plan to teach in the remainder of the school year?

	Taught	Plan to teach	Have not taught and don't plan to teach
Lesson 1: Roots	☐	☐	☐
Lesson 2: Stems	☐	☐	☐
Lesson 3: Leaves	☐	☐	☐
Lesson 4: Photosynthesis	☐	☐	☐
Lesson 5: Flowers	☐	☐	☐
Lesson 6: Sexual Reproduction	☐	☐	☐
Lesson 7: Asexual Reproduction	☐	☐	☐
Lesson 8: GMOs	☐	☐	☐
Lesson 9: Seeds	☐	☐	☐
Lesson 10: Germination	☐	☐	☐
Lesson 11: Data Collection	☐	☐	☐
Lesson 12: Elements of Growth	☐	☐	☐
Lesson 13: Nutrients	☐	☐	☐
Lesson 14: Soil Texture	☐	☐	☐
Lesson 15: Biofuels	☐	☐	☐

ND Science in CTE Experimental Ag Teacher Follow Up

A4b Lesson Modification

To what extent did you modify or change the lessons that you taught?

- ◯ I modified or changed every lesson.
- ◯ I modified or changed most of the lessons.
- ◯ I modified or changed about half of the lessons.
- ◯ I modified or changed a few of the lessons.
- ◯ I did not modify or change any of the lessons.

If you made modifications or changes to the lessons, why did you do so? Please describe in some detail.

To what extent do you believe your students' Agricultural Education course achievement was enhanced after using the lessons developed for the study?

- ◯ Greatly Enhanced
- ◯ Moderately Enhanced
- ◯ Somewhat Enhanced
- ◯ Slightly Enhanced
- ◯ Not Enhanced

To what extent do you believe your secondary Agricultural Education curricula were reduced with the implementation of the enhanced science concepts?

- ◯ Greatly Reduced
- ◯ Moderately Reduced
- ◯ Somewhat Reduced
- ◯ Slightly Reduced
- ◯ No Change

ND Science in CTE Experimental Ag Teacher Follow Up

A5 Parts of Lessons

***Have you used or do you plan to use parts of the science-enhanced lessons (but not the whole lesson) in any of your classes?**

- ◯ Yes
- ◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

A5a Number of classes

How many classes with parts of the science-enhanced lessons have you taught?

How many classes with parts of the science-enhanced lessons do you plan to teach in the remainder of the school year?

Which of the science-enhanced lessons have you taught a part of the lesson and which lessons do you plan to teach a part of in the remainder of the school year?

	Taught portions	Plan to teach portions	Have not taught and don't plan to teach portions
Lesson 1: Roots	☐	☐	☐
Lesson 2: Stems	☐	☐	☐
Lesson 3: Leaves	☐	☐	☐
Lesson 4: Photosynthesis	☐	☐	☐
Lesson 5: Flowers	☐	☐	☐
Lesson 6: Sexual Reproduction	☐	☐	☐
Lesson 7: Asexual Reproduction	☐	☐	☐
Lesson 8: GMOs	☐	☐	☐
Lesson 9: Seeds	☐	☐	☐
Lesson 10: Germination	☐	☐	☐
Lesson 11: Data Collection	☐	☐	☐
Lesson 12: Elements of Growth	☐	☐	☐
Lesson 13: Nutrients	☐	☐	☐
Lesson 14: Soil Texture	☐	☐	☐
Lesson 15: Biofuels	☐	☐	☐

ND Science in CTE Experimental Ag Teacher Follow Up

A6 7 Element Approach

***Have you adopted any parts of the 7-element teaching approach, that is, going from specific agricultural applications to general science underlying the applications in your agriculture classes?**

- ◯ Yes
- ◯ No

ND Science in CTE Experimental Ag Teacher Follow Up

A6a 7 Element Approach Adopted

What parts have you adopted?

Element 1. Introduce the lesson

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 1?

Element 2. Assess students' science awareness as it relates to the agricultural application

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 2?

Element 3. Work through the science embedded in the agricultural application

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 3?

Element 4. Work through related, contextual examples

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 4?

Element 5. Work through explicit science examples

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 5?

ND Science in CTE Experimental Ag Teacher Follow Up

Element 6. Students demonstrate their understanding

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 6?

Element 7. Formal assessment

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 7?

ND Science in CTE Experimental Ag Teacher Follow Up

B1 Not teaching agriculture

If you are not teaching secondary Agricultural Education courses this school year, please indicate why you are not doing so.

- [ ] No longer teaching, changed careers, retired
- [ ] Have non-teaching position, counselor, administrator, etc.
- [ ] Am teaching non-secondary Agriculture Education courses
- [ ] Am teaching secondary Agricultural Education courses that do not prepare students for employment
- [ ] Other (please describe)

ND Science in CTE Experimental Ag Teacher Follow Up

B2 Teaching Agriculture

If you are teaching secondary Agricultural Education courses, but are not including explicit instruction in science, please indicate your reasons. (Check all that apply.)

- ☐ Do not have time, too much agricultural content to cover
- ☐ Do not have the background/experience to teach science
- ☐ Do not think it appropriate to attempt to teach science in my classes
- ☐ Do not have access to science teacher who could provide support in teaching science
- ☐ Other (please specify)

ND Science in CTE Experimental Ag Teacher Follow Up

Thank You A

***BY COMPLETING AND RETURNING THIS QUESTIONNAIRE, I AGREE TO PARTICIPATE IN AN INTERVIEW CONCERNING THE EXPLICIT SCIENCE INSTRUCTION I INCLUDE IN MY SECONDARY AGRICULTURAL EDUCATION CLASSES.**

◯ Finish

ND Science in CTE Experimental Ag Teacher Follow Up

Thank You B

***BY COMPLETING AND RETURNING THIS QUESTIONNAIRE, I AGREE TO PARTICIPATE IN AN INTERVIEW CONCERNING REASONS WHY I HAVE NOT INCLUDED EXPLICIT SCIENCE INSTRUCTION IN MY SECONDARY AGRICULTURAL EDUCATION CLASSES.**

◯ Finish

ND Science in CTE Experimental Ag Teacher Follow Up

Finish

Thank you for completing this questionnaire! Please provide an address in the space below where your $50 stipend can be sent.

APPENDIX G. ONLINE QUESTIONNAIRE—SCIENCE TEACHERS

ND Science in CTE Science Teacher Follow Up

Informed Consent

Dear Science-in-CTE Pilot Study Participant:

The Agricultural and Extension Education program in NDSUs School of Education in the College of Human Development and Education invites you to participate in a follow-up study to the Science-in-CTE study you participated in during the 2009-2010 school year. Please read this form and ask any questions you may have before agreeing to continue in the study.

Background Information:
The purpose of this study is to determine if the professional development model is sustainable in Agricultural Education and Science. This involves a new method of obtaining quality professional development and a new way of teaching science in the regular Agricultural Education and Science curricula.

Project Title:
Sustainability of Professional Development to Enhance Student Achievement: A Shift in the Professional Development Paradigm

Investigators:
Dr. R. Brent Young, Principal Investigator
Mrs. Wendi M. Mizer Stachler, Co-Investigator

Procedures:
If you agree to participate in this study, you will agree to do the following:
- Complete an on-line questionnaire about your use of explicit science instruction in your secondary Agricultural Education and/or Science courses
- Participate in a telephone or personal interview following the questionnaire

Risks and Benefits of Participation:
This study will test if explicit science instruction in Agricultural Education courses is sustainable for secondary Agricultural Education teachers. It will test if the methods or examples developed in the Pilot Study are sustainable for secondary Science teachers. If the Pilot Study's procedures were successful, you have been a more effective teacher and your students have increased their understanding of science concepts and their applications.

You will receive a $50 stipend for completing the on-line questionnaire. Participants who are selected to participate in and complete a personal interview will receive an additional $50 Wal-mart Gift Card.

Confidentiality:
The records of this study will be kept private. Personal and telephone interviews will be audio taped and transcribed. As names will be initially included on the on-line survey, the raw data will not be anonymous. Confidentiality, however, will be promised in any report or publication. We will keep your name and data, as well as those of your students and school, completely anonymous and confidential. In any report we might publish, we will not include any individual information that will make it possible to identify a subject.

The co-Investigator will keep all the data and audio-tapes in a secure location for three years after the conclusion of the study. At which time, the material will be destroyed.

Voluntary Nature of the Study:
Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with North Dakota State University. If you decide to participate, you are free to withdraw at any time, but you will not receive the gift card for the portion (s) you did not complete (i.e. on-line questionnaire, telephone interview, or personal interview).

Contacts and Questions:
If you have any questions about this study, you may contact the Principal Investigator, Dr. R. Brent Young, Assistant Professor, at Brent.Young@ndsu.edu, phone: 701/231-7439; or the co-Investigator, Mrs. Wendi M. Mizer Stachler, Graduate Student, at Wendi.M.Stachler@ndsu.edu, phone: [redacted]. They will be serving as the researchers for this study.

ND Science in CTE Science Teacher Follow Up

If you have any questions or concerns regarding the rights of research participants or to report a complaint about this research, contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu, phone: 701/231-8908.

Statement of Consent:
I have read the above information. I have asked questions and have received answers. By clicking on the link below, I consent to participate.

***Do you accept?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

Teaching Science

We appreciate your willingness to assist us with this follow-up survey. Please select your responses to the questions below. If marking 'other,' a box will be provided for you to clarify your answer. Thank you.

Please type your first and last name. This information will be used only to identify who to contact for follow-up interviews. Your name will then be changed to a number.

***Are you teaching science classes this school year (fall 2010 through spring 2011)?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

Included Methods

***Have you included any of the methods or examples from the lessons developed for the Science-in-CTE study in your science classes?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A1 Section A

***Have you used any agricultural examples of the applications of science from the Science-in-CTE lessons in your classes?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A1a Agricultural Examples

Please list the agricultural examples you have used.

ND Science in CTE Science Teacher Follow Up

A2 Lessons Taught

***Have you taught or do you plan to teach any of the science-enhanced lessons or parts of the lessons that were developed for the Science-in-CTE study?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A2a Lessons Taught List

Which lesson(s) have you taught and which lesson(s) do you plan to teach in the remainder of the school year?

	Taught	Plan to teach	Have not taught and don't plan to teach
Lesson 1: Roots	☐	☐	☐
Lesson 2: Stems	☐	☐	☐
Lesson 3: Leaves	☐	☐	☐
Lesson 4: Photosynthesis	☐	☐	☐
Lesson 5: Flowers	☐	☐	☐
Lesson 6: Sexual Reproduction	☐	☐	☐
Lesson 7: Asexual Reproduction	☐	☐	☐
Lesson 8: GMOs	☐	☐	☐
Lesson 9: Seeds	☐	☐	☐
Lesson 10: Germination	☐	☐	☐
Lesson 11: Data Collection	☐	☐	☐
Lesson 12: Elements of Growth	☐	☐	☐
Lesson 13: Nutrients	☐	☐	☐
Lesson 14: Soil Texture	☐	☐	☐
Lesson 15: Biofuels	☐	☐	☐

ND Science in CTE Science Teacher Follow Up

A3 7 Element Approach

***Have you adopted any parts of the 7-element teaching approach, that is, going from specific agricultural applications to general science underlying the applications in your science classes?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A3a 7 Element Approach Adopted

What parts have you adopted?

Element 1. Introduce the lesson

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 1?

Element 2. Assess students' science awareness as it relates to the agricultural application

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 2?

Element 3. Work through the science embedded in the agricultural application

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 3?

Element 4. Work through related, contextual examples

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 4?

Element 5. Work through explicit science examples

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 5?

ND Science in CTE Science Teacher Follow Up

Element 6. Students demonstrate their understanding

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 6?

Element 7. Formal assessment

- ◯ Adopted
- ◯ Not Adopted

How did you adopt Element 7?

ND Science in CTE Science Teacher Follow Up

A4 Ag Ed Contact

***During the current school year, does the Agricultural Education instructor(s) with whom you worked during the research ever contact you to review the teaching of science concepts?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A4a Contact Frequency

If you have any contacts with the Agricultural Education instructor(s), how frequent are they?

- ◯ Less than once a month or less
- ◯ Once a month
- ◯ Once every two or three weeks
- ◯ About once a week
- ◯ Almost every day

ND Science in CTE Science Teacher Follow Up

A5 Other Ag Ed Contacts

***During the current school year, do other Agricultural Education instructors contact you to review the teaching of science concepts?**

- ◯ Yes
- ◯ No

ND Science in CTE Science Teacher Follow Up

A5a Other Contact Frequency

If you have any contacts with other Agricultural Education instructor(s), how frequent are they?

- ◯ Less than once a month
- ◯ Once a month
- ◯ Once every two or three weeks
- ◯ About once a week
- ◯ Almost every day

ND Science in CTE Science Teacher Follow Up

B2a Not teaching science

If you are not teaching science courses this school year, please indicate why you are not.

- [ ] No longer teaching, changed careers, retired
- [ ] Have non-teaching position, counselor, administrator, etc.
- [ ] Am not teaching science courses
- [ ] Other (please describe)

ND Science in CTE Science Teacher Follow Up

B2b Teaching Science

If you are teaching science courses, but are not including anything from the Science-in-CTE lessons, please indicate your reasons. (Check all that apply.)

- ☐ Agricultural examples too specific, my students do not have background needed to understand applications
- ☐ Science-in-CTE examples do not fit in my curriculum
- ☐ Curriculum too full already, cannot bring more material in
- ☐ Science in these lessons is not at a level appropriate for my classes
- ☐ Do not have access to CTE teacher to provide background/support on using agricultural examples
- ☐ Other (please specify)

ND Science in CTE Science Teacher Follow Up

Thank You A

***BY COMPLETING AND RETURNING THIS QUESTIONNAIRE, I AGREE TO PARTICIPATE IN AN INTERVIEW CONCERNING THE METHODS OR MATERIALS FROM THE SCIENCE-IN-CTE LESSONS THAT I HAVE USED IN MY CLASSES.**

◯ Finish

ND Science in CTE Science Teacher Follow Up

Thank You B

***BY COMPLETING AND RETURNING THIS QUESTIONNAIRE, I AGREE TO PARTICIPATE IN AN INTERVIEW CONCERNING REASONS WHY I HAVE NOT INCLUDED ANYTHING FROM THE SCIENCE-IN-CTE LESSONS IN MY CLASSES.**

◯ Finish

ND Science in CTE Science Teacher Follow Up

Finish

Thank you for completing this questionnaire! Please provide an address in the space below where your $50 stipend can be sent.

APPENDIX H. SURVEY CONFIRMATION/INTERVIEW CONSENT—CTE TEACHERS WITH AFFIRMATIVE RESPONSE

SURVEY CONFIRMATION/INTERVIEW CONSENT E-MAIL
Experimental and Control CTE—Affirmative Response

Date

Dear (**CTE Teacher Name**):

Thank you very much for completing the follow-up questionnaire. We will process your $50 stipend as quickly as possible. We appreciate your on-going support in our efforts to ascertain the sustainability of the North Dakota Pilot Study's *Science-in-CTE* model.

Because you reported on the survey that you have taught or plan to teach the science-enhanced lessons in the 2010-2011 academic year, I am interested in scheduling a personal interview with you to discuss your use of the lessons in more depth. For your participation, you will receive another $50 stipend.

In the next few days, I will contact you to schedule a personal interview. I will travel to meet with you at a location and time of your choosing. During the interview, you will be asked to focus on two of the lessons you reported teaching on the questionnaire. I will ask you about your use of the pedagogic framework and ask you to walk me through the lessons as you taught them.

You are not under any obligation to be interviewed as a result of your participation in the North Dakota *Science-in-CTE* Pilot Study, but we hope you will. Your responses will help us in planning for future implementation of the *Science-in-CTE* model.

Your responses to interview questions will be kept confidential. In any kind of publication or report, we will not include information that will make it possible to identify you, your school, or your students. All research records are stored securely and only the researchers will have access to them. Interviews will be audio-taped and transcribed. The tapes will be destroyed three years following the conclusion of the study.

The lead researcher in this study is Dr. R. Brent Young. If you have any questions, you are welcome to contact him at phone: 701/231-7439 or e-mail Brent.Young@ndus.edu. You may also contact me, Wendi M. Mizer Stachler, at phone: [redacted] or e-mail Wendi.M.Stachler@ndsu.edu.

If you have any questions or concerns regarding this study and would like to talk with someone other than the researchers, you are encouraged to contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu or phone 701/231-8908.

Your continued cooperation in this research effort is essential for this follow-up to yield accurate information as we move forward. And once again, thank you for all your contributions to the success of the *Science-in-CTE* study.

Sincerely,

[redacted]

Mrs. Wendi M. Mizer Stachler & Dr. R. Brent Young
Agricultural & Extension Education
North Dakota State University
School of Education
College of Human Development & Education
NDSU Department #2625
PO Box 6050
Fargo, ND 58108-6050

APPENDIX I. INTERVIEW SCHEDULING SCRIPT

North Dakota Science-in-CTE Pilot Study Follow-up

INTERVIEW SCHEDULING SCRIPT
(for all participating teachers; phone or e-mail)

I am contacting you on behalf of the North Dakota State University. Thank you again for returning the Science-in-CTE Pilot Study Follow-up survey.

Phoning note: If calling a school and you reach the front desk or principals' office, politely introduce yourself and ask if they can connect you to the teacher without interrupting the classroom. If the teacher is unavailable or teaching, ask for a direct phone number or extension and the best time(s) to call back when the teacher is available.

*As we indicated in our most recent e-mail message to you, we are interested in learning more about your choice [**CTE**: to use or not to use the science-enhanced lessons] or [**Science**: to use or not to use methods, materials, agricultural examples from the Science-in-CTE study.] Knowing this will help us as we plan for future implementations of the model.*

Phone interviews for all negative responders: *"I would like to schedule a brief, 10-15 minute phone interview with you as a follow-up to the survey. I want this to be as convenient as possible to your schedule. When are the best times to reach you in the next week [two weeks]? [after school, before school, planning periods, evening at home, weekends]?"* [Confirm a time and correct phone number to call and thank them.]

In-person interviews, CTE teacher affirmative responders: "*I would like to schedule a time for an in-person interview as a follow-up to the survey. I will need about an hour of uninterrupted time to meet. I indicated in my e-mail message that we would like to focus the interview on two randomly-selected lessons you have taught this year. These will be [indicate which lessons based on survey response]. When we meet, I will ask some specific questions about these lessons. I want the time and location to be as convenient as possible for you. I am attempting to schedule interviews the week(s) of ___. Would you be available during that time? If not, when might you be available to meet?* [Confirm a date, time and location].

In-person interviews, science teacher affirmative responders: "*I would like to schedule a time for an in-person interview as a follow-up to the survey. I will need about 30 minutes of uninterrupted time to meet. When I come, I will ask some specific questions about how you have utilized the Science-in-CTE methods or examples. I want the time and location to be as convenient as possible for you. I am attempting to schedule interviews the week(s) of ___. Would you be available during that time? If not, when might you be available to meet?* [Confirm a date, time and location].

If a teacher has any further questions/concerns, please arrange for Dr. Young to phone him/her.

In any case, if a teacher refuses an interview, please assure him/her that there is no obligation to participate and thank them for the return of their survey.

APPENDIX J. PERSONAL INTERVIEW CONSENT SCRIPT

North Dakota Science-in-CTE Pilot Study Follow-up

PERSONAL INTERVIEW CONSENT SCRIPT

We want to thank you for participating in the North Dakota *Science-in-CTE* Pilot Study follow-up survey. Before we start, I want to make sure that you read and understood the consent letter and that you understand the purpose of this interview.

[Interviewer will provide a hard copy of the Survey Confirmation/Interview Consent Letter and/or read through as needed]

Do you have any questions before we begin?

This interview will be recorded and transcribed. Every effort will be made to ensure confidentiality and privacy. Your name will be changed to an ID number and will not be associated with any data from this interview. The transcriptions will be kept in a secured location. In any sort of report we might publish, we will not include any information that will make it possible to identify you, your students, or your school.

If any time along the way you do not wish to answer a question or continue the interview, please let me know.

APPENDIX K. PERSONAL INTERVIEW QUESTIONS—EXPERIMENTAL AND CONTROL CTE TEACHERS

North Dakota Science-in-CTE Pilot Study Follow-up
CTE TEACHER INTERVIEW QUESTIONS

Interviewer reads interview consent script (attached)

The focus of this interview is to help us get a better picture of how you are utilizing explicit science instruction and the Science-in-CTE model in your classes in this academic year following the study.

Overall, what can you tell me about the extent of your use of the Science-in-CTE model in your classroom this year? What are your reasons for this, or what has compelled you to use the model in these ways?

***If teacher indicated using another model for teaching science, ask*:** What can you tell us about other approaches you use in making the science explicit in your teaching? How do you use these methods? Examples? How do these approaches/methods impact on your use of the Science-in-CTE model?

I want to focus this part of our interview specifically on two of the lessons you reported teaching this year. Will you walk me through both lessons and the 7 elements in each of these lessons?

[*Teacher will have been informed in advance which two lessons will be the focus of the interview. Using the lesson plan as a guide, teacher walks through the lessons; interviewer asks clarifying questions and takes notes]*

You have indicated that you make modifications to the enhanced lessons. How would you characterize those modifications? Can you provide me with some examples?

Are you using all 7 elements of the framework, or selecting only parts of lessons to teach? If so, what are you using and why? Explain? Examples?

Can you provide me with some examples that show how you are using methods, materials, or examples from the study?

What has impacted your choices about which of the science-enhanced lessons you teach or not teach? Explain? Examples?

What kinds of new lessons or instructional materials have you developed in the year following the study?

Experimental teachers only:
One of the outcomes teachers identified as bringing success to the study was the relationships of CTE-science teacher partners and the communities of practice that formed as a result. What can you tell me about sustaining professional interactions with your science-teacher partner following the study? Have you been able to maintain contact or work together in some way? Have you been able to maintain contact with other teams from the study? What is the nature of that interaction—examples?

> ***If teacher indicates working with another science teacher:*** How did you select another science teacher to work with? What is the nature of the interaction—examples?

Control teachers only as indicated by the survey response:

You indicated on the survey that you are in contact with a science teacher. How did you go about finding the science teacher support? Would you describe the kind of science support or help you receive? Examples?

Overall, how did your participation in the Science-n-CTE study impact your overall approach to instruction as an Agricultural Educator in the year following the study?

Any final comments?

Interviewer concludes:

Do you have any further comments? Do you have any questions?
Thank you once again for taking time to talk with me.

If you have any questions in the future, you may contact Dr. Young.
[refer phone number and e-mail address if requested]

APPENDIX L. SURVEY CONFIRMATION/INTERVIEW CONSENT—SCIENCE TEACHERS WITH AFFIRMATIVE RESPONSE

SURVEY CONFIRMATION/INTERVIEW CONSENT
Science Teachers; Affirmative Response

Date

Dear (**Science Teacher Name**):

Thank you very much for completing the follow-up survey. We appreciate your ongoing support in our efforts to ascertain the sustainability of the *Science-in-CTE* model. We will process your $50 Wal-mart Gift Card as quickly as possible. It will be mailed to the address you provided.

Because you reported on the survey that you have used methods, materials, or agricultural examples from the *Science-in-CTE* study during the 2010-2011 academic year, we are interested in scheduling a personal interview with you to discuss this in more depth. For your participation, you will receive another $50 Wal-mart Gift Card.

In the next couple days, I will contact you to schedule a personal interview. I will travel to you at a location and time of your choosing. During the interview, you will be asked more about what, why, and how you are using aspects of the *Science-in-CTE* model in your classes.

You are not under any obligation to be interviewed as a result of your participation in the North Dakota *Science-in-CTE* Pilot Study, but we hope you will. Your responses will help us in planning for future implementation of the *Science-in-CTE* model.

Your responses to interview questions will be kept confidential. In any kind of publication or report, we will not include information that will make it possible to identify you, your school, or your students. All research records are stored securely and only the researchers will have access to them. Interviews will be audio-taped and transcribed. The tapes will be destroyed three years following the conclusion of the study.

The lead researcher in this study is Dr. R. Brent Young. If you have any questions, you are welcome to contact him at phone: 701/231-7439 or e-mail Brent.Young@ndus.edu.

You may also contact me, Wendi M. Mizer Stachler, at phone: [redacted] or e-mail Wendi.M.Stachler@ndsu.edu.

If you have any questions or concerns regarding this study and would like to talk with someone other than the researchers, you are encouraged to contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu or phone 701/231-8908.

Your continued cooperation in this research effort is essential for this follow-up to yield accurate information as we move forward. And once again, thank you for all your contributions to the success of the *Science-in-CTE* study.

Sincerely,

[redacted]

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North Dakota State University
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APPENDIX M. PERSONAL INTERVIEW QUESTIONS—SCIENCE TEACHERS

North Dakota Science-in-CTE Pilot Study Follow-up
SCIENCE TEACHER INTERVIEW QUESTIONS

Interviewer reads interview consent script (attached)

Overall, what can you tell me about the extent of your use of the Science-in-CTE model in your classroom this year? What are your reasons, or what has compelled you to use the model in these ways?

You indicated on the follow-up survey that you have been using methods, materials, and/or agricultural examples [refer survey]. Could you explain or describe this in more detail?

What kinds of agricultural examples have you been utilizing in your instruction?
How extensively do you use these examples and why?

If you utilize the 7-elements in your instruction, how do you do it? Would you walk me through a couple of examples?

What are some other ways you have used the Science-in-CTE methods or materials in your classes?

One of the outcomes teachers identified as bringing success to the study was the relationships of CTE-science teacher partners and the communities of practice that formed as a result. What can you tell me about sustaining professional interactions with your CTE-teacher partner following the study? Have you been able to maintain contact or work together in some way? Have you been able to maintain contact with other teams from the study? What is the nature of that interaction-- examples?

Option: You indicated that you contacted or worked with other CTE teachers. How did you choose the teachers to whom you talked? Did you seek out a certain area of CTE? If so, why? Did you ask them for examples to use in your class? If so, did you use the examples?

Overall, how did your participation in the Science-in-CTE study impact your overall approach to instruction as a Science teacher?

Any final comments?

Interviewer concludes:

Do you have any further comments? Do you have any questions?
Thank you once again for taking time to talk with us.

If you have any questions in the future, you may contact Dr. Young.
[refer phone number and e-mail address if requested]

APPENDIX N. SEVEN-ELEMENT PEDAGOGICAL MODEL FOR SCIENCE-IN-CTE

The Science-in-CTE Pedagogic Framework
The "Seven Elements" of a Science-Enhanced CTE Lesson

1. Introduce the CTE lesson.
   - Explain the CTE lesson.
   - Identify, discuss, point out, or pull out the science embedded in the CTE lesson.

2. Assess students' science awareness as it relates to the CTE lesson.
   - As you assess, introduce the science vocabulary embedded in the CTE lesson.
   - Employ a variety of methods and techniques for assessing awareness of all students—e.g., questioning, group learning activities, etc.

3. Work through the science *embedded* in the CTE lesson.
   - Work through the concepts, principles, or processes of the embedded science.
   - Bridge the CTE and science language. The transition from CTE to science vocabulary should be gradual throughout the lesson, being sure never to abandon completely either set of vocabulary once it is introduced.

4. Work through *related, contextual* science-in-CTE examples.

   Using the same science concept *embedded* in the CTE lesson:
   - Work through similar problems/examples in the same occupational context.
   - Use examples with varying levels of difficulty; order examples from basic to advanced.
   - Continue to bridge CTE and science vocabulary.
   - Check for understanding.

5. Work through traditional math examples. Using the same math concept as in the embedded and related, contextual examples:
   - Work through traditional math examples as they may appear on tests.
   - Move from basic to advanced examples.
   - Continue to bridge CTE and math vocabulary.
   - Check for understanding.

6. Students demonstrate their understanding.
   - Provide students opportunities for demonstrating their understanding of the science concepts embedded in the CTE lesson.
   - Conclude the science examples and tie back to the CTE content; conclude the lesson on the topic of CTE.

7. Formal assessment.
   - Incorporate science questions into formal assessments at the end of the CTE unit/course.

APPENDIX O. SURVEY CONFIRMATION/INTERVIEW CONSENT—CTE TEACHERS WITH NEGATIVE RESPONSE

SURVEY CONFIRMATION/INTERVIEW CONSENT
Experimental and Control CTE; Negative Response

Date

Dear (**CTE Teacher Name**):

Thank you very much for returning the follow-up survey. We appreciate your ongoing support in our efforts to ascertain the sustainability of the *Science-in-CTE* model. I will process your $50 payment as quickly as possible. If you requested the gift card be mailed, it will arrive by mail at the address you provided. If you requested the gift card be hand-delivered during the State FFA Convention or Region III National Association of Agricultural Educators Convention, I will make arrangements to meet with you.

Because you reported on the survey that you have not taught the science-enhanced lessons in the 2010-2011 academic year, we are interested in scheduling a telephone interview with you to learn more about your reasons for not using them. In the next couple days, I will contact you to schedule an interview at a day and time of your choosing.

You are not under any obligation to be interviewed as a result of your participation in the North Dakota *Science-in-CTE* Pilot Study, but we hope you will. Your responses will help us in planning for future implementation of the *Science-in-CTE* model.

Your responses to interview questions will be kept confidential. In any kind of publication or report, we will not include information that will make it possible to identify you, your school, or your students. All research records are stored securely and only the researchers will have access to them. Interviews will be audio-taped and transcribed. The tapes will be destroyed three years following the conclusion of the study.

The lead researcher in this study is Dr. R. Brent Young. If you have any questions, you are welcome to contact him at phone: 701/231-7439 or e-mail Brent.Young@ndus.edu.

You may also contact me, Wendi M. Mizer Stachler, at phone: [redacted] or e-mail Wendi.M.Stachler@ndsu.edu.

If you have any questions or concerns regarding this study and would like to talk with someone other than the researchers, you are encouraged to contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu or phone 701/231-8908.

Your continued cooperation in this research effort is essential for this follow-up to yield accurate information as we move forward. And once again, thank you for all your contributions to the success of the *Science-in-CTE* study.

Sincerely,

[redacted]

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APPENDIX P. SURVEY CONFIRMATION/INTERVIEW CONSENT—SCIENCE TEACHERS WITH NEGATIVE RESPONSE

SURVEY CONFIRMATION/INTERVIEW CONSENT
Science Teachers; Negative Response

Date

Dear (**Science Teacher Name**)

Thank you very much for returning the follow-up survey. We appreciate your ongoing support in our efforts to ascertain the sustainability of the *Science-in-CTE* model. We will process your $50 payment as quickly as possible. We will process your $50 Wal-mart Gift Card as quickly as possible. It will be mailed to the address you provided.

Because you reported on the survey that you have not used materials, methods, or agricultural examples from the *Science-in-CTE* study, I are interested in scheduling a telephone interview with you to learn more about your reasons for not using them. In the next couple days, I will contact you to schedule an interview at a day and time of your choosing.

You are not under any obligation to be interviewed as a result of your participation in the North Dakota *Science-in-CTE* Pilot Study, but we hope you will. Your responses will help us in planning for future implementation of the *Science-in-CTE* model.

Your responses to interview questions will be kept confidential. In any kind of publication or report, we will not include information that will make it possible to identify you, your school, or your students. All research records are stored securely and only the researchers will have access to them. Interviews will be audio-taped and transcribed. The tapes will be destroyed three years following the conclusion of the study.

The lead researcher in this study is Dr. R. Brent Young. If you have any questions, you are welcome to contact him at phone: 701/231-7439 or e-mail Brent.Young@ndus.edu.

You may also contact me, Wendi M. Mizer Stachler, at phone: [redacted] or e-mail Wendi.M.Stachler@ndsu.edu.

If you have any questions or concerns regarding this study and would like to talk with someone other than the researchers, you are encouraged to contact the NDSU Human Research Protection Program at ndsu.irb@ndsu.edu or phone 701/231-8908.

Your continued cooperation in this research effort is essential for this follow-up to yield accurate information as we move forward. And once again, thank you for all your contributions to the success of the *Science-in-CTE* study.

Sincerely,

[redacted]

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APPENDIX Q. TELEPHONE INTERVIEW CONSENT SCRIPT

North Dakota Science-in-CTE Pilot Study Follow-up

PHONE INTERVIEW CONSENT SCRIPT

Thank you for participating in the North Dakota *Science-in-CTE* Pilot Study follow-up survey. Before we start, I want to make sure that you read and understood the consent letter and that you understand the purpose of this interview.

We are interested in learning more about your reasons for not using [**CTE**: the science-enhanced lessons] [**Science**: using methods, materials, examples from the Science-in-CTE Study]

Do you have any questions? [Interviewer will have consent letters available to read if necessary].

This interview will be recorded and transcribed. Every effort will be made to ensure confidentiality and privacy. Your name will be changed to an ID number and will not be associated with any data from this interview. The transcriptions will be kept in a secured location. In any sort of report we might publish, we will not include any information that will make it possible to identify you, your students, or your school.

If any time along the way you do not wish to answer a question or continue the interview, please let me know.

APPENDIX R. TELEPHONE INTERVIEW QUESTIONS

North Dakota Science-in-CTE Pilot Study Follow-up

TELEPHONE INTERVIEW QUESTIONS
(for CTE and Science teachers who indicate on the survey that they are not using the Science-in-CTE model)

Before questioning, interviewer will follow telephone consent script (attached)

Experimental and Control CTE Teachers

I are interested in following up on your responses to the Science-in-CTE follow-up survey you returned. Thank you, again, for your willingness to let me talk with you in more detail about your answers.

Interviewer will ask B1 or B2, as indicated by the individual's survey

B1. You indicated on your survey that you are not currently teaching CTE courses that prepare students for employment. In the future if you do return to teaching CTE courses would you choose to include explicit science instruction in your courses?

a. If yes: What are your reasons for doing so? What would you choose to teach and why? Would you follow the Science-in-CTE pedagogy (the 7 elements)? Could you explain/describe more? Could you provide examples? Do you have other comments you would like to share?

b. If no: What are your reasons for choosing not to teach explicit science in your courses? Could you explain/describe more? Could you provide some (other or specific) examples? Do you have other comments you would like to share?

B2. You indicated on your survey that you are teaching CTE courses that prepare students for employment, but that you are not including explicit science instruction because [refer reasons indicated on survey.] I would like to hear more about [refer reason]. Could you explain/describe more? Could you provide some (other or specific) examples? Do you have other comments you would like to share?

Science Teachers

I are interested in following up on your responses to the Science-in-CTE follow-up survey you returned. Thank you again for your willingness to let us talk with you in more detail about your answers.

B1. You indicated on your survey that you are not currently teaching science courses this year.

In the future, if you do return to teaching science courses would you choose to include any methods, materials, or agricultural examples from the Science-in-CTE study in your courses?

a. If yes: What are your reasons for doing so? What would you choose to teach and why? Would you use any of the Science-in-CTE pedagogy (the 7 elements)? Could you explain/describe more? Could you provide examples? Do you have other comments you would like to share?

b. If no: What are your reasons for choosing not to use any methods, materials, or examples from the Science-in-CTE study in your courses? Could you explain/describe more? Could you provide some (other or specific) examples? Do you have other comments you would like to share?

B2. You indicated on your survey that you are teaching science courses, but that you are not including anything from the Science-in-CTE study instruction because [refer reasons indicated on survey.] I would like to hear more about [refer reasons]. Could you explain/describe more? Could you provide some (other or specific) examples? Do you have other comments you would like to share?

Interviewer concludes:

Do you have any further comments? Do you have any questions?
Thank you once again for taking time to talk with me.

If you have any questions in the future, you may contact Dr. Young.
[refer phone number and e-mail address if requested]