

Sustainability of professional development to enhance student achievement: A shift in the professional development paradigm

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The purpose of this study was to describe the sustainability of professional development, specifically the teacher utilization of the Science-in-CTE pedagogical model and science-enhanced agricultural education lessons in curricula one year following the Science-in-CTE pilot study. This quasi-experimental study included 41 teachers (15 treatment agricultural education, 14 control agricultural education, and 12 science) who participated in seven days of professional development 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. Researchers found that a majority of the treatment agricultural education and science teachers voluntarily incorporated portions of the seven-element pedagogical model and 15 science-enhanced lessons into their curricula one year later. However, less than 30% of the control agricultural education teachers incorporated the method or materials from the pilot study into their curricula. Findings suggest that collaborative, extended professional development is sustainable and an effective method of integrating science content into agricultural education curricula to enhance student course achievement without reducing the intent of the agricultural education program.

Keywords: professional development, transtheoretical model, behavior change, academic achievement

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In 1998, the Carl D. Perkins Vocational and Technical Education Act, Public Law 105-332 (USDE, 2002), subsequently 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 degree. Other requirements included competency-based, applied, and occupationally-specific learning, as well as learning that included higher-order reasoning and problem-solving skills. 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 (CTE). 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. Although 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). 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 has increased quickly 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 (“Carl D. Perkins,” 2006) specifically addressed 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).

CTE programs have experienced 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. No Child Left Behind (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 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 (Martin, Fritzsche, & Ball, 2006).

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 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, agricultural education 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 believed the primary concern was the increase in core academic courses students were

required to complete for high school graduation. 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 believed NCLB would cause a negative impact on CTE programs.

The need for quality professional development to enhance CTE courses with the integration of STEM concepts is unmistakable. Unfortunately, few teachers receive 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). According to Yoon, Duncan, Lee, Scarloss, and Shapley (2007), traditional professional developments are designed 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’” (p. 1). Ruhland and Bremer (2002) further described traditional professional development 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.

How can teachers shift their pedagogy to effectively integrate core academics into their CTE curricula without losing 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). In 2012, Perkins IV required CTE teachers to change their method of teaching CTE curricula by incorporating core academic content into their programs of instruction. Boardman and Woodruff (2004) addressed four strategies of professional development that were vital to sustainable teaching and learning opportunities:

1. Teachers appear less concerned with how professional development is delivered if it provides quality content. However, teachers still expect overall effective professional development.

2. Teachers expect new information that is content-specific, has practical applications, and is relevant to their program.
3. 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.
4. 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.

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? 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, however 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 the effectiveness that quality teacher professional development had on increasing student academic scores. Both studies demonstrated the effect Math-in-CTE had within 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 were components addressed in the Math-in-CTE study (Lewis & Pearson, 2007). The Math-in-CTE study was a quasi-experimental study that involved 136 CTE teachers and nearly 1,600 CTE students. Teachers were randomly divided into two equal groups—treatment and control. The control teachers taught the CTE curriculum as they had planned. The teachers assigned to the treatment group were each partnered with a

mathematics teacher prior to developing and teaching math-enhanced CTE lessons. The treatment 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 treatment CTE teachers' programs. In the end, the study concluded that students who received the math-enhanced CTE lessons out-performed students who had not received a math-enhanced curriculum (Stone et al., 2007; ACTE, 2009). The intensity of professional development received was cited as a leading factor of the Math-in-CTE study's success.

CTE teachers have genuine concerns about the impact academic integration will have on CTE programs that are already dealing with certain constraints such as managing 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). 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 believed 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. Despite 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).

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 CTE teachers in the treatment group, 52 mathematics teachers, and 73 CTE teachers in the control group. Based on the mixed-methods data that were collected from the original study, the treatment teachers believed that extensive 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 treatment teachers reported continued use of the pedagogic model and the math-enhanced lessons developed during the study. The teachers in the control group who received minimal professional development reported limited effectiveness (Lewis & Pearson, 2007).

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 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. CTE teachers in the treatment group were partnered with mathematics teachers for the duration of the study. The study by Parr et al. (2008) was conducted during spring semester of 2004 and included 18 experimental classrooms. Young et al. (2009) conducted a study during 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.

Theoretical Framework

There are various models of change that could be employed to help teachers modify their pedagogy. One such method is the trans-theoretical model of behavior change (Prochaska, Johnson, & Lee, 2009; Prochaska, DiClemente, & Norcross, 1992; see Figure 1). 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. The preparation stage shows 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 individuals will typically spend a majority of their time in this stage. A sixth stage, which 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).

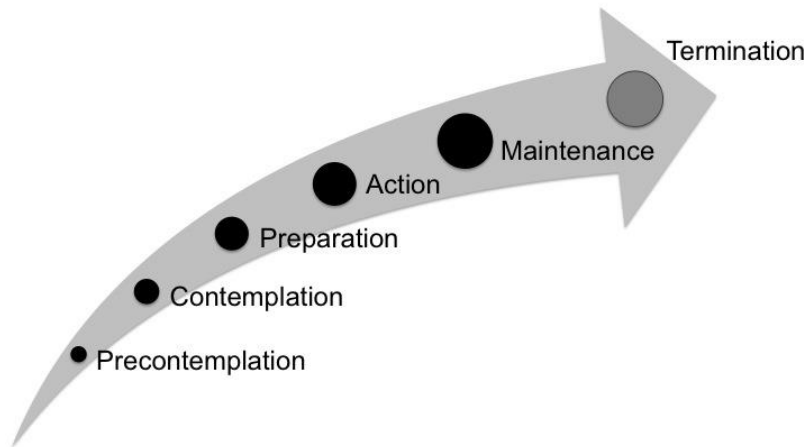


Figure 1. The six stages of Prochaska's transtheoretical model of behavior change.

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. In a study of more than 1,000 mathematics and science teachers, collective participation was listed as one of the characteristics that made professional development effective (Garet, Porter, Desimone, Birman, & Yoon, 2001). Collaborative professional development can be used to bring about positive and effective change to CTE and core academic teachers.

Purpose

The purpose of this study was to describe the sustainability of professional development, specifically the teacher utilization of the Science-in-CTE pedagogical model and science-enhanced agricultural education lessons in curricula one year following the Science-in-CTE pilot study. The Science-in-CTE follow-up study was a partial replication of the Math-in-CTE follow-up study. The information obtained from this follow-up research study would be beneficial to secondary agricultural education and science teachers by providing sustainable

professional development practices and pedagogy that would bridge CTE and core academic curricula to enhance student achievement.

Research Questions

Utilizing two research questions, this follow-up study was conducted to describe the sustainability of seven days of intensive professional development between secondary agricultural education and science teachers.

1. To what extent did agricultural education teachers who participated in the 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 did science teachers who worked with the experimental agricultural education teachers use the pedagogical model or any of the occupational examples from the lessons developed in their academic classes?

Method

A Science-in-CTE pilot study (Pearson et al., 2010) was conducted in 2009-2010 among 41 North Dakota agricultural education and science teachers (15 agricultural education teachers assigned to the treatment group, 14 agricultural education teachers assigned to the control group, and 12 science teachers partnered with teachers in the treatment group). The pilot study was a partial replication of the Math-in-CTE Study. In the Science-in-CTE pilot study, an open invitation to participate in the study was sent to all 77 North Dakota secondary agricultural education teachers listed in the teacher directory (NDAAE, 2009) in the fall of 2009. A total of 29 agricultural education teachers responded and represented 29 different schools in the state. The 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.

Each experimental agricultural education teacher was paired with a secondary science teacher partner for the duration of the study, and these partners participated in seven days of intensive professional development. Science-enhanced agricultural education lesson plans were developed by the agricultural education/science teacher partners and evaluated by their peers. Each agricultural education teacher in the experimental group had the opportunity to teach all 15 lessons to his or her students. The control group did not receive additional professional development, science partner assistance, or supporting materials. Control teachers were asked to continue teaching the traditional agricultural education 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.

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 agricultural education and science educators and students as was observed with the Math-in-CTE participants. This idea for a Science-in-CTE follow-up study was discussed with the coordinators of the pilot study that was developed by the National Research Center for Career and Technical Education (NRCCTE). It was determined that NRCCTE would not conduct their follow-up study; yet there was an expressed interest in discovering the sustainability of the science-enhanced agricultural education lessons that were developed using the seven-element teaching model. The Science-in-CTE follow-up study was designed to investigate the extent to which agricultural education teachers continued to use the science-enhanced lessons and seven-element teaching model one year after the conclusion of the pilot study.

As a partial replication, 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. It was determined that similar components would be utilized in the science follow-up, including a questionnaire and personal or telephone interviews. Slight modifications were made to reflect the needs within the academic science content and North Dakota agricultural education programs. The questions included on the questionnaire were derived from the Math-in-CTE follow-up study that had been previously conducted. 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 NRCCTE.

A mixed-methods research approach to data collection was used (Creswell, 2002). The questionnaire was designed to conduct survey research that primarily obtained quantitative data. The questionnaire also included open-response questions where qualitative data were collected. Qualitative data were collected through personal and telephone interviews. Responses from the personal and telephone interviews were compared to responses from the

questionnaires to further evaluate the extent of use or justification of non-usage of the science-enhanced lessons.

Online questionnaire

Online questionnaires were used to ascertain the extent teachers used the pedagogical model or any of the science-enhanced agricultural education 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 in March 2011 and disabled in September 2011. Participants were only permitted to log into the online questionnaire once.

The design of the online questionnaires was established using contingency questions (Lavrakas, 2008). As participants answered questions, they were automatically directed to corresponding questions on the questionnaire. For example, if a participant indicated he or she had included explicit science instruction, he or she was directed toward questions dealing with the specifics of that science instruction. However, if a participant indicated on the questionnaire he or she had not included any explicit science instruction, he or she was directed past any questions relating to the specifics about science instruction. Rather, he or she was directed to a question to clarify the negative response.

Using contingency questions, affirmative responses from agricultural education 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. Agricultural education 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.

Personal and Telephone Follow-up Interviews

Although 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. Based on the completed online questionnaire, agricultural education teachers who indicated using explicit science instruction or parts of the pedagogical model in their lessons were contacted to participate in personal interviews. Science teachers who indicated using methods, materials, or agricultural examples from the Science-in-CTE pilot study were also invited to complete a personal interview. 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. Personal interview questions were used to establish continuity within the agricultural education and science groups. However, the script provided the researcher with some flexibility to ask clarifying questions based on participant responses. The personal interviews lasted an average of 25-35 minutes for science teachers and 40-60 minutes for agricultural education teachers.

All personal interviews (agricultural education and science) focused on two random lessons the teachers indicated they had taught in its entirety or as a portion. Small tags were numbered one through 15 that 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 described the lessons as they had taught them, describing the lessons using the seven-elements in the pedagogical model. All personal interviews were audio recorded. To compensate them for their time, teachers who completed a personal interview were given an additional \$50 honorarium.

Agricultural education 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 email inviting them to participate in a short telephone interview. Telephone interview consent scripts were read at the beginning of each telephone interview followed by a brief set of 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 to those who reported not using the lessons or model. 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.

Findings/Results

An email invitation was sent to all 41 participants (15 experimental agricultural education, 14 control agricultural education, and 12 science teachers) of the Science-in-CTE pilot study inviting them to participate in the follow-up study. Thirty-five out of 41 participants completed the online questionnaire for an overall response rate of 85% (see Table 1). All of the agricultural education teachers (100%) in the treatment group completed the online questionnaire, as well as 10 of the 14 agricultural education teachers in the control group (71%) and 10 of the 12 science teachers (83%).

Table 1

Invitations Emailed and Online Questionnaires Completed

Teacher Group	Emailed	Questionnaires Completed	Response %
Experimental	15	15	100.0
Control	14	10	71.4
Science	12	10	83.3
Total	41	35	85.4

Research Question 1 Findings.

Thirteen (87%) of the 15 experimental agricultural education teachers who completed the online questionnaire reported the inclusion

of explicit science instruction that was designed to teach the concepts inherent within their secondary agricultural education courses (see Table 2 and Figure 2). These teachers were eligible for a personal follow-up interview. The

remaining two teachers (13%) did not teach secondary agricultural education courses during the 2010-2011 school year and received a telephone follow-up interview. Therefore, of the 13 experimental teachers who taught explicit science and received a personal follow-up

interview, 12 (92%) used a combination of Science-in-CTE materials that included the science-enhanced lessons and the pedagogical model. The one remaining teacher declined to be interviewed after completing the online questionnaire.

Table 2

Use of Science-in-CTE Method or Materials During 2010-2011 School Year by Experimental Agricultural Education 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.

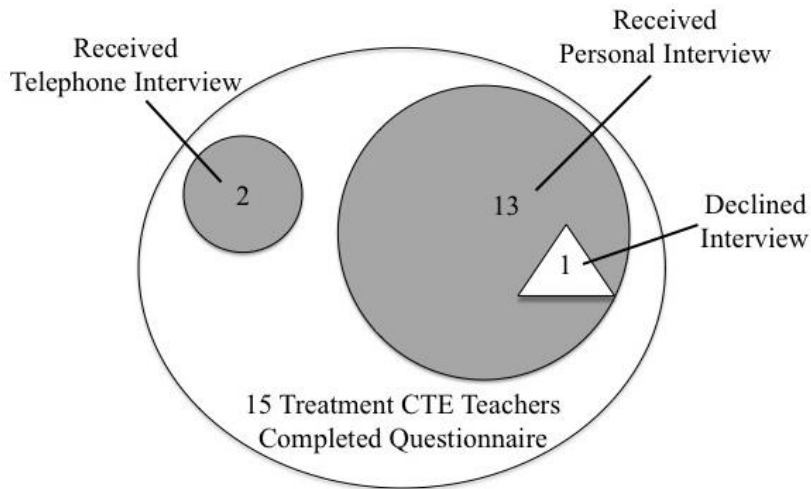


Figure 2. Experimental agricultural education teacher response rate to the online questionnaire and subsequent personal and telephone follow-up interviews conducted.

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, whereas 31% of the experimental teachers also indicated using district/school-specific materials.

Ten of the 14 control agricultural education teachers completed the questionnaire (see Table

3 and Figure 3). Of the 10 control teachers, one (10%) reported that he or she was no longer teaching agricultural education courses and two (20%) reported they had taught agricultural education courses that did not include explicit science. The remaining seven (70%) control agricultural education teachers indicated they had taught explicit science a year after the pilot study, but only two (29%) of those teachers indicated that they had used the Science-in-CTE method and lessons in their curricula.

Table 3

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

Use of method or lessons	<i>n</i>	%
Taught explicit science	7	70.0
Used Science-in-CTE method and lessons	2	28.6
Used other methods	7	100.0
Taught CTE courses, but not explicit science	2	20.0
Did not teach CTE courses	1	10.0

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

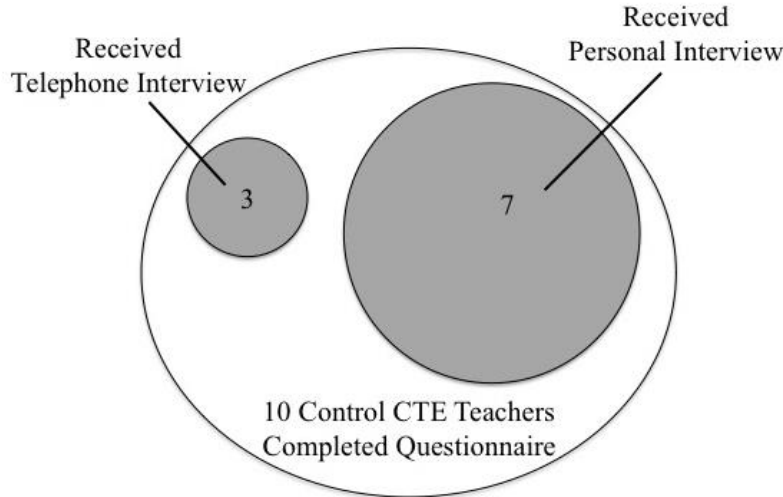


Figure 3. Control agricultural education teacher response rate to the online questionnaire and subsequent personal and telephone follow-up interviews conducted.

Research Question 2 Findings.

The data were analyzed to determine the extent to which science teachers who worked with the experimental agricultural education teachers used the pedagogical model or any of the occupational examples from the lessons that were developed in their academic classes. Ten of the 12 science teachers completed the

questionnaire (see Table 4 and Figure 4). Of the 10 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.

Table 4

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.

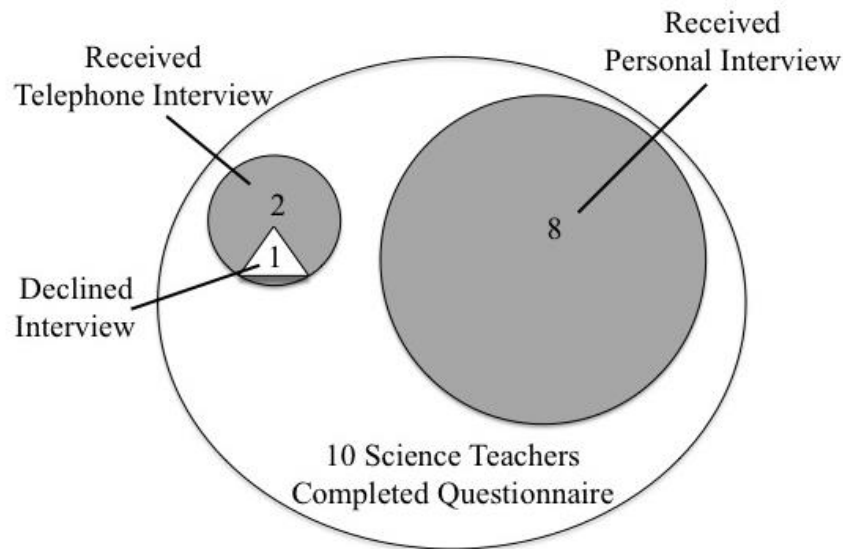


Figure 4. Science teacher response rate to the online questionnaire and subsequent personal and telephone follow-up interviews conducted.

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. Of the four science teachers who adopted any part of the seven-element model, all (100%) teachers adopted elements one, six, and seven into their instruction. Elements two and three were adopted by half (50%) of the teachers. One science teacher made a slight modification to element three and the students worked through the agriculture embedded within the science. The remaining two elements, elements four and five, were adopted by three (75%) of the four science teachers.

Conclusions

No attempt at generalization should be made from the results of this study beyond its intended population. Data were collected from a small sample in one state. Additionally, the potential

for non-response bias exists because no attempt was made to gather data from participants after the data collection period ended. Due to extenuating circumstances (flooding) during the spring of 2011, the data collection period was extended through the summer months and concluded on September 15, 2011. Four attempts were made to contact participants who had not yet completed the questionnaire—two email reminders within the first two weeks of June 2011 and two email reminders between August 10 and September 15, 2011. Personal contact was also made with control teachers who had not yet completed the questionnaire during two summer CTE conferences.

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. Of the 41 possible participants, 35 (85%) completed the online questionnaire and 33 (81%) completed either a personal or telephone interview. Although intrinsic motivation seemed to have elicited positive results, one cannot forget that an extrinsic motivator, a monetary honorarium, was used.

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 mathematics and science content could be integrated into CTE curricula without losing 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. Literature suggested traditional one-day, fragmented workshops were not enough to sustain professional growth (Ruhland & Bremer, 2002; Boardman & Woodruff, 2004; Kedzior & Fifield, 2004; Lewis & Pearson, 2007; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). This will mean a shift 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 trans-theoretical 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. A new model of professional development is sustainable as demonstrated by 92% of the experimental agricultural education teachers who attained the maintenance phase of the transtheoretical model of behavior change and continued to use the Science-in-CTE lessons and model one year following the pilot study (see Figure 5). In contrast, only 29% of control agricultural education teachers utilized materials received from the traditional professional development. Upon completion of the pilot study, none of the teachers (agricultural education or science) received technical support, added professional development, or monetary compensation for continuing to use the lessons or model. While the pilot study's professional development focus was on the experimental agricultural education teachers, an unexpected, yet very positive consequence occurred as 80% of the science teachers elected to incorporate portions of the lessons or model into their curricula.

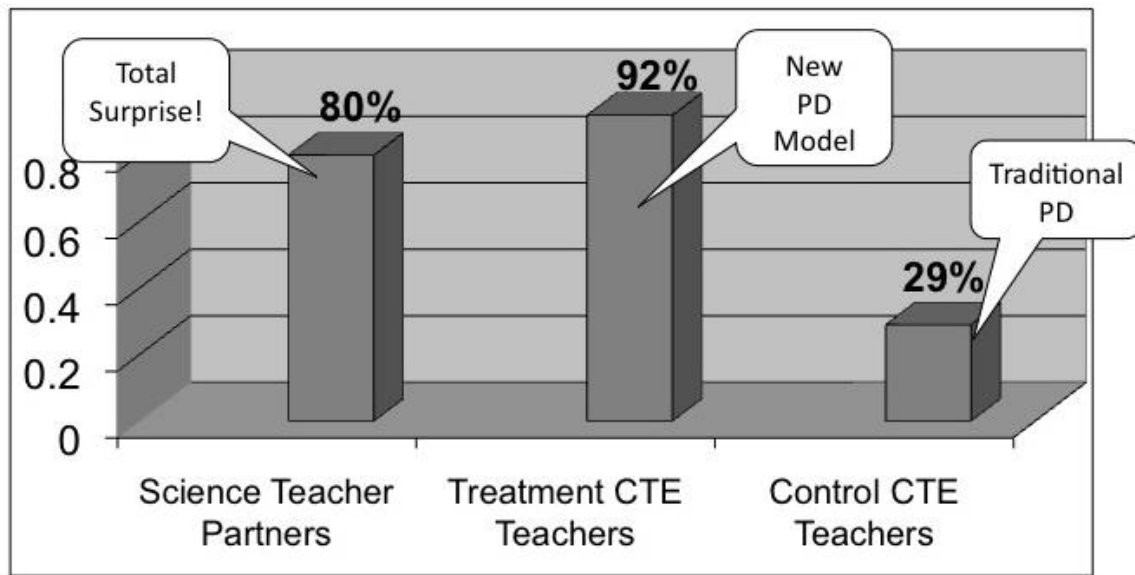


Figure 5. Use of Science-in-CTE methods or materials during 2010-2011 school year by agricultural education and science teachers who responded to the questionnaire.

Implications of the Findings

The Science-in-CTE follow-up study showed that the new method and delivery of the professional development is sustainable. The model combined professional development and pedagogy. The number of CTE teachers in the treatment group (92%) who continued to use the methods and lessons one year after the pilot study concluded was consistent with the 73% usage from teachers in the treatment group reported in the Math-in-CTE follow-up study (Lewis & Pearson, 2007, pg. 14, Table 3). Similarly, science teachers responded with an 80% usage rate as compared to the 66% usage rate from math teachers (Lewis & Pearson, 2007, pg. 18, Table 7). When comparing CTE teachers in the control group from each of the follow-up studies, similar results were found with a mere 29% usage rate from the Science-in-CTE control teachers and 27% from the Math-in-CTE control teachers (Lewis & Pearson, 2007, pg. 14, Table 3).

Based on the high percentage of lessons that were taught by experimental agricultural education 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 agricultural education teachers who were each in the treatment group described the professional development:

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.

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

education teacher explained why he or she 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.”

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

Recommendations

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

1. Would the methods and model be sustainable strictly as a professional development without the confines associated with a research study?
2. Is the Science-in-CTE model adaptable to other agricultural education instructional units or topics? Other CTE content areas?

3. Would teachers continue to utilize the model in years following the professional development?
4. Would teachers benefit from a periodic “refresher” professional development? If so, how soon following a professional development?

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 quasi-experimental research study. CTE and science teachers assigned to the treatment group perceived that the professional development was effective in producing collaborations among teacher partners and content areas. The treatment CTE teachers’ perceptions were that development and utilization of the science-enhanced lessons increased student achievement. Therefore, the information obtained from this study would be beneficial to secondary agricultural education and science teachers by providing sustainable professional development practices and pedagogy that can bridge CTE and core academic curricula to enhance student achievement.

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