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Introducing a Precision Soil Conservation Curriculum: A Pre- and Post-Evaluation

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Abstract

The need for sustainable agricultural practices will not only be satisfied by reaching traditional farmers, but by reaching to all populations regardless of their agricultural background. The lack of agricultural literacy in secondary agricultural education has also been a concern in recent years, spurring the development of relevant and up-to-date curricula. This study focused on the implementation of a precision soil conservation curriculum in high school agricultural education programs located on the impaired South Fork Watershed of the Iowa River in Iowa. Within this study's settings and context, the curriculum implementation effectiveness was measured by students' attitudes and content knowledge acquisition. Our curriculum implementation, overall, appeared to have been effective. However, we do acknowledge that the effectiveness of the curriculum implementation could be defined broadly or affected by many other variables. Therefore, we suggest collecting further student data after large scale implementation of the curriculum.

***Keywords*:** Curriculum development, Soil conservation

Introduction

The need for sustainable agricultural practices is becoming increasingly important as the world's population continues to skyrocket. With this growth in population, new areas of investigation have begun in soil quality in relation to water quality and land degradation (Mermut & Eswaran, 2001). Almost 50% of the United States' land is devoted to cropping, rangeland, or pasture uses (U.S. Department of Agriculture, 2013). In order to remain globally competitive, emphasis in agriculture is being placed on the ability to minimize costs while maximizing productivity (McConnell & Burger, 2011).

Precision agriculture offers the potential to increase yields while minimizing costs and environmental impacts through advancing technologies (Stull, Dillon, Shearer, & Isaacs, 2004). Precision conservation has been defined as "a set of spatial technologies and procedures linked to mapped variables directed to implement conservation management practices that take into account spatial and temporal variability across natural and agricultural systems" (Berry, Delgado, Khosla, & Pierce, 2003, p. 332). Precision conservation is intended to maintain and increase crop production while preventing unnecessary inputs in addition to decreasing the loss of sediments, nutrients and other chemicals to the environment (Delgado, Berry, & Khosla, 2008). Computerization management makes precision agriculture the most advanced approach to farming (Mermut & Eswaran, 2001). According to Buman (2013), "conservation technology offers the best opportunity for conservation planning to be integrated with production agriculture" (p. 96A). For example, precision conservation has been used to establish conservation buffers to reduce topsoil erosion and reduce nutrient runoff (Dosskey, Eisenhauer, & Helmers, 2005; Stull et al., 2004).

With a focus at the state level, Iowa has a need for soil research due to its high soil erosion rates and poor water quality (Cruse, Paulsen, Dabney, Polush, Ridgely, & Buman, 2012). Further, researchers have suggested that Iowa's surface water quality is less than desirable and the state has been recognized as one of the largest contributors of phosphorus to the Northern Gulf of Mexico (Jacobson, David, & Drinkwater, 2011). Many state that this problem needs to be addressed by starting at the grassroots level.

"Although most producers desire to be good stewards of natural resources and value environmental services that their land produces, economic constraints often hinder adoption" (McConnell & Burger, 2011, p. 351). Gamon and Scofield (1996) concluded that though young farmers showed positive interest in sustainable agriculture, few changes have occurred over time. These younger farmers were also more inclined to believe that sustainable agriculture would offer more benefits to society than what established farmers believed (Gamon & Scofield, 1996). Mermut and Eswaran (2001) stated "the need for soil information to support agriculture resulted in the teaching of soils as an integral part of the agricultural curriculum" (p. 405). Studies regarding sustainable agriculture have shown that farmers, teachers, students, and extension agents—young and old alike—have more to learn about sustainable agriculture (Williams & Wies, 1997; Gamon & Scofield, 1996). A need for agricultural knowledge leads to the concern for developing agricultural literacy (Powell & Agnew, 2011).

"A more collaborative approach to standards-based curriculum, incorporating both academic and agricultural content, has the potential to unify previously segmented proponents of agricultural literacy while still addressing the larger curriculum needs of a changing society" (Powell & Agnew, 2011, p. 167). Hopkins (2014) and Ball and Cohen (1996) recognized the responsibility of practicing teachers, the government, and other stakeholders in sharing curriculum objectives and goals with students. Hopkins believes this is what will facilitate democratic curriculum. In response to John Dewey's perspective on democratic education, Hopkins (2014) further noted that "a school curriculum needed to reflect and build upon the wider interpretation of knowledge and understanding held by citizens in society at large" (p. 418). Workers, voters, family, and community activists represent citizens within a society. The foundation of a democratic curriculum should be the shared quest for knowledge by all of those involved in the learning environment (Hopkins, 2014). Considering curriculum developed through a bottom-up approach and achieving agricultural literacy, it is necessary to include the teachers in the facilitation of curriculum development, as well as gain the students' perception of the value and desired outcome of the curriculum.

Conceptual Framework

Teachers play an important role in developing and implementing dynamic curriculum (Agbaje, 1998), and it is this dynamic aspect of curriculum development that will continue to meet the demands of the changing agricultural industry. Teaching involves a cyclical process of seeking, learning, application, evaluation, and reflection. For teachers to offer the most up-to-date methods and materials for their students, they must be trained in the current content and have the most up-to-date curriculum available. In the mid-1990s, the Project Food, Land and People (2012) project was developed in response to the concern for agricultural literacy among the agriculturally based population. Though there are lessons and curriculum designed specifically for many agricultural topics, erosion is a major concern in the agricultural sector, and is an area which has not been heavily discussed at the high school level (Cruse, et al., 2012). In order to introduce curriculum focused upon erosion and precision conservation at the high school level, a curriculum development model was utilized to guide the process.

The Curriculum Development Process, proposed by the Food and Agricultural Organization of the United Nations (FAOUN) (2013), provided the foundation for this study. This model, displayed in Figure 1, articulates the phases, steps, and relations in developing a successful curriculum. From identifying the problem to evaluating the curriculum strategies, the Curriculum Development Guide provided specific details and critical questions to consider when revising existing or designing new curriculum. First, a need or a "gap" at the local level must be identified in order to begin the curriculum development process. Questions need to be asked in order to identify the pressing issues: What materials can make a difference? Are others currently considering this issue? What organizations or companies can contribute resources to make a difference? Who is the target audience? What means should be used to address the issue(s)? (Food and Agriculture Organization of the United Nations, 2013).

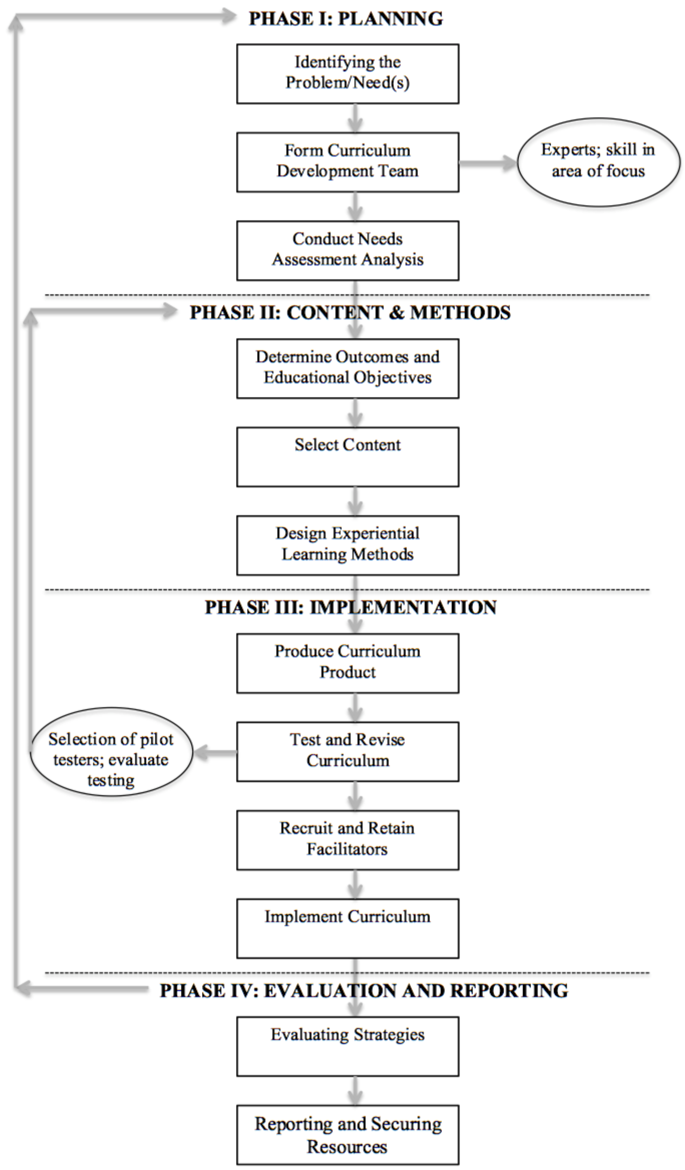

Figure 1. The Curriculum Development Process. Developed from Food and Agriculture Organization of the United Nations (2013).

Once the problem(s) are identified, a curriculum development team should be arranged. Experts in content, writers, editors, members of the target audience, and educational designers should all be involved in the curriculum development process (Food and Agriculture Organization of the United Nations, 2013). Agbaje (1998) suggested that some of the most credible and beneficial information relative to sustainable agriculture emerges from university researchers. A needs assessment should then be formulated to determine the goals of the teachers, students, and community. Research has suggested that the expertise of teachers makes them best suited to determine which methods will most effectively address the challenges in education today (McCulloch, Burris, & Ulmer, 2011), especially those involved in the development and decision making of agricultural education curriculum (Byrd, Anderson, Paulsen, & Shultz, 2015). However, the challenge remains for agricultural educators to find ways to improve the current curriculum in a manner that will provide a more meaningful experience for their students (Nolin

& Parr, 2013), and still meet the expectations of community and policy makers (Ball & Cohen, 1996). From the feedback gained during the planning phase, content and methods can then become the primary focus of a proposed or revised curriculum. By establishing formal educational outcomes and objectives, the content and experiential learning methods should then be outlined (Food and Agriculture Organization of the United Nations, 2013).

During the implementation phase, it is essential to select pilot testers in order to run an initial evaluation of the curriculum. Determined by the suggestions and usability of the content and methods, the curriculum development process continues or cycles back to the content and methods phase (Food and Agriculture Organization of the United Nations, 2013). The curriculum is then implemented, followed by thorough evaluations. Specific assessments should be designed to determine the value of all or part of the curriculum (Food and Agriculture Organization of the United Nations, 2013). Finally, based on the results of the evaluations, it can be determined whether there is a need for more curriculum development, further feedback, or additional resources.

Purpose and Objectives

The purpose of this study was to test the effectiveness of the implementation of a precision soil conservation curriculum developed through a democratic, team approach. As part of a larger research project funded by the United Stated Department of Agriculture (USDA) National Institute of Food and Agriculture, research, education, and extension personnel collaborated to establish criteria that would assist in reducing the effects of ephemeral gully erosion on water quality (Cruse, et al., 2012). This research aligns with the American Association for Agricultural Education Research Priority 2: New Technologies, Practices and Products. The key outcome of this Priority area states, “Agriculturalists, rural landowners, homeowners, and consumers will embrace new technologies, practices, and products derived through agricultural and natural resources research” (Doerfert, 2011, p. 15). This study focused upon numerous stakeholders in the South Fork Iowa River Watershed area and across Iowa. This study also helped meet one objective of the grant project by developing precision soil conservation “instruction[al] units to educate high-school agricultural and FFA students on types of water erosion, erosion control practice, and the water quality benefits associated with precision conservation” (Cruse et al., 2012, p. 1). The following objectives were determined to guide this study:

1) Determine the difference, if any, between the students’ attitudes towards the importance of soil and water conservation as a result of curriculum implementation.
2) Determine the difference, if any, between the students’ soil and water conservation knowledge attainment as a result of curriculum implementation.

Methodology

A Precision Conservation Planning Curriculum was developed by agricultural educators at Iowa State University with four secondary agricultural education teachers in the South Fork Watershed in Iowa using a democratic theory approach (Hopkins, 2014). Seven Iowa high school agricultural education teachers participated in the study and implemented the two-to-four week precision soil conservation curriculum. An initial needs assessment determined content the teacher-participants had previously taught and had hoped to teach relating to soil and water conservation. The preferred number of class periods required to implement the curriculum was also identified by the participant-teachers. Based upon the goals of the National Institute of Food and Agriculture (2012) U. S. Department of Agriculture grant project and needs assessment, specific content appropriate for the secondary level was determined and developed collaboratively by university content and curriculum development researchers and secondary agricultural education instructors. Four secondary agricultural education teachers from high schools in the South Fork watershed were invited to and attended a two-day training workshop. This workshop was held prior to the curriculum implementation. Teacher-participants provided feedback regarding content, teaching methods, and assessment throughout and after the training through focus groups. Activities and lessons were edited and approved by the teacher-participants and content validated by experts in the field to determine content relevancy prior to implementation of the curriculum with their students. The teacher-participants provided state-level training to 63 agricultural education teachers at a summer workshop. Three additional teachers were recruited to assist in testing the curriculum in their high schools. Iowa State University Institutional Review Board approval included securing permission and consent from the school principal and agricultural education teachers. Parental consent and student assent was secured from all students prior to participating in the implementation study.

All curriculum materials were distributed to the teachers during the fall of 2014 or fall of 2015. The teachers were asked to implement the complete curriculum and associated assessments prior to the end of the given semester. Assessments were based upon the twenty-three primary outcomes of the curriculum. Each student (n = 52) was asked to complete a soil conservation pre-perception assessment pretest based upon the objectives in the precision soil conservation curriculum. Students were given four choices regarding level of agreement on a Likert-type scale to determine attitudinal perceptions of objectives related to soil and water conservation presented in the curriculum. The students were also asked to complete a pre-content assessment to determine understanding of precision soil conservation prior to the implementation of the curriculum. This assessment was made up of multiple choice questions that were determined based upon the objectives of the curriculum. After curriculum implementation, participating students completed a post-perception assessment. Quizzes and activities within the curriculum lessons were provided for the teachers to use at their discretion, but not collected as a part of evaluation for this study. Students were asked to provide selected demographic information as a part of the post-perception assessment. Usable student assessments (n = 52, 62.7%) were collected and recorded in Excel.

Differences in students' pre- and post-attitudinal perceptions were determined by conducting a paired samples t-test. Mean scores and standard deviations were computed for the perception assessments. Pre- and post-perception assessments were comprised of the same statements, both based upon the curriculum objectives. A four-point agreement scale was used, 4 = *Strongly Agree*, 3 = *Agree*, 2 = *Disagree*, and 1 = *Strongly Disagree*. A paired-samples t-test was conducted to evaluate the impact of the precision soil conservation curriculum on students' content knowledge scores. Pre- and post-content knowledge assessments were based upon the objectives of the curriculum. Effect size for changes in attitudinal perceptions were measured using eta-squared.

Results

Participants

The majority of the participants were sophomores in high school (n = 38, 73.1%), not active in nonformal agricultural youth organizations (e.g., 4-H) (n = 40, 76.9%), and were members of FFA (n = 34, 65.4%). Twenty-four (46.2%) of the participants lived in town. Table 1 provides an overview of the participant demographics.

Table 1. Summary of Respondents' Selected Demographic Characteristics (n=52)

	f	*%*
Grade		
9th grade	4	7.7
10th grade	38	73.1
11th grade	6	11.5
12th grade	4	7.7
FFA Involvement		
Yes	34	65.4
No	18	34.6
Youth Organization Involvement		
Yes	12	23.1
No	40	76.9
Place of Residence		
In town	24	46.2
In country (non farm)	11	21.2
In country (farm)	17	32.7

Objective one sought to determine the differences, if any, between the students' attitudes towards the importance of soil and water conservation as a result of curriculum implementation. The guidelines proposed by Cohen (1988) for interpreting effect size using eta-squared were used: 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect. Twelve of twenty (60.0%) attitude importance statements demonstrated a statistically significant, positive difference between students' pre- and post-assessments. Of those, four (33.3%) reported large effect sizes and eight (66.7%) reported moderate effect sizes. The curriculum had the largest effect on the following attitude importance statements: *It is important that I understand what soil erosion is* (MD = .54; t = 3.46, $p < .05$, $\eta^2_p = .21$); *I know the potential impacts of soil erosion on water quality* (MD = .42; t = 3.70, $p < .05$, $\eta^2_p = .21$). Overall, the curriculum made a difference in students' attitudes towards soil and water conservation. Table 2 displays the paired samples t-test of students' pre- and post-attitudinal perceptions (*n=52*).

Table 2. Paired Samples t-Test of Pre- and Post-Attitudinal Perceptions of Precision Soil Conservation Curriculum (n=52)

Objective	Pre-test *M*	Pre-test *SD*	Post-test *M*	Post-test *SD*	*MD*	*t*	*df*	*Effect Size*
It is important that I understand what soil erosion is	3.17	0.62	3.46	0.54	0.29	3.64*	51	0.21
I know the potential impacts of soil erosion on water quality	3.02	0.70	3.44	0.54	0.42	3.70*	51	0.21
There are positive aspects of soil erosion practices	2.94	0.85	3.38	0.57	0.44	3.33*	51	0.18
Precision conservation technology can reduce soil erosion	2.96	0.66	3.31	0.76	0.35	2.83*	51	0.14
Water quality within my own watershed is important	3.10	0.75	3.44	0.64	0.35	2.76*	51	0.13
Operational conservation practices are important to reduce soil erosion	3.10	0.66	3.40	0.53	0.31	2.68*	51	0.12
Understanding the water cycle helps me understand soil erosion	2.79	0.64	3.08	0.55	0.29	2.60*	51	0.12
I can have an impact on landowners and other stakeholders by educating them about soil erosion	2.88	0.68	3.21	0.70	0.33	2.55*	51	0.11
It is necessary that I understand how to calculate erosion rates of different fields using the USLE = Universal Soil Erosion Equation	2.62	0.69	2.88	0.70	0.27	2.44*	51	0.10
It is important that I know the differences among types of soil erosion	3.00	0.66	3.23	0.55	0.23	2.13*	51	0.08
New emerging technologies will continue to be important in reducing soil erosion	3.08	0.71	3.33	0.65	0.25	2.15*	51	0.08
Structural conservation practices are important to reduce soil erosion	3.08	0.68	3.33	0.55	0.25	1.95	51	0.07
Understanding the nitrogen cycle helps me understand soil erosion	2.77	0.65	2.98	0.64	0.21	1.85	51	0.06
It is necessary that I understand factors that affect soil erosion (for example: slope, soil erodibility, tillage practices, etc.)	3.12	0.55	3.29	0.72	0.17	1.70	51	0.05
Understanding the phosphorus cycle helps me understand soil erosion	2.81	0.66	2.98	0.67	0.17	1.29	51	0.03
I can have a personal impact on soil erosion in my community by implementing soil conservation practices when possible	3.10	0.75	3.25	0.74	0.15	1.13	51	0.02
Reducing soil erosion is important to me	3.19	0.72	3.29	0.72	0.10	0.80	51	0.01
It is important that I know the watershed in which I live	2.88	0.78	2.96	0.88	0.08	0.70	51	0.01

Note: 4 = Strongly Agree, 3 = Agree, 2 = Disagree, and 1 = Strongly Disagree. MD = mean difference (posttest minus pretest). * indicates significant at $p < .05$.

Objective two sought to determine the difference, if any, between the students' soil and water conservation knowledge attainment as a result of curriculum implementation. Table 3 denotes the frequency and percentage (*n*=52) of correct responses on the content knowledge assessment. Students answered the questions relating to the water cycle and the definition of soil erosion correctly more often than any other question on the pre-content assessment. Students answered these same questions correctly more often than any other question on the post-content assessment. The percentage of students who correctly answered questions regarding LiDAR advantages, the soil erosion nutrient, and conservation practice implementation showed no improvement from the pre-to-post content knowledge assessments.

Table 3. Frequency and Percentage of Students' Correct Responses to the Precision Soil Conservation Curriculum Assessment (N=52)

	Pre-Content		Post-Content	
Objective of Question	*f*	*(%)*	*f*	*(%)*
Define soil Erosion	40	85.1	44	93.6
Define the soil erosion process-detachment	28	59.6	40	85.1
Define the soil erosion process-transport	25	53.2	28	59.6
Define the soil erosion process-deposition	22	46.8	29	61.7
Define rill erosion	12	25.5	35	74.5
Define gully erosion	28	59.6	37	78.7
Identify factors of soil erosion	22	46.8	38	80.9
Define USLE	11	23.4	14	29.8
Identify specific factors of USLE	16	34.0	33	70.2
Compute USLE	15	31.9	30	63.8
Define operational conservation practices	18	38.3	33	70.2
Determine conservation practice implementation	18	38.3	19	40.4
Determine local watershed	40	85.1	43	91.5
Identify water cycle process-precipitation	36	76.6	42	89.4
Identify water cycle process-evaporation	42	89.4	45	95.7
Identify sources of nitrogen in nitrogen cycle	24	51.1	36	76.6
Identify phosphorous as the soil erosion nutrient	13	27.7	16	34.0
Interpret water quality tests, pH	32	68.1	40	85.1
Interpret water quality tests, turbidity	14	29.8	27	57.4
Explain phosphates in water sources	11	23.4	13	27.7
Define precision conservation	17	36.2	19	40.4
Compare DEM vs. LiDAR technology	12	25.5	34	72.3
LiDAR advantages	17	36.2	17	36.2
Precision technology, drones	26	55.3	43	91.5

Table 4 displays overall average student content knowledge scores at the pre- and post-curriculum implementation. There was a statistically significant increase from the pre- ($M = 10.69$, $SD = 3.30$) to the post-content knowledge assessment scores ($M = 15.87$, $SD = 4.05$), $t(51) = 7.1425$, $p < .05$ (two-tailed) on the twenty-four question exam. The mean increase in content assessment scores was 5.18 with a 95% confidence interval ranging from 3.74 to 6.61. The eta-squared statistic (0.65) indicated a large effect size (Cohen, 1988).

Table 4. Results of Paired Samples t-Test of Overall Pre- and Post-content Assessment (N=52)

	Pre-test		Post-test					Effect
	M	*SD*	*M*	*SD*	*Diff*[a]	*t*	*df*	*Size*
Content Scores	10.69	3.30	15.87	4.05	5.18	7.1425*	51	0.65

Note. * = significant at $p < .05$ [a] = post-test minus pre-test.

Conclusions and Discussion

Students indicated an increase in agreement with all of the attitudinal perception statements after the implementation of the precision soil conservation curriculum. In twelve of the twenty perception statements, students indicated a statistically significant increase from pre- to post-test. Four items showed a large effect size: *understanding soil erosion*, *acknowledging positive aspects of soil erosion practices*, *precision conservation technology can reduce soil erosion*, and *the potential impacts of soil erosion on water quality*. The increase in students' attitudes towards the importance of soil erosion aspects may be predictive of the large increase in students' content knowledge scores regarding the same objective. However, it is difficult to determine why students showed an increase in attitude towards the importance of new emerging technology in precision soil conservation, yet demonstrated a decrease in one of the four content scores related to precision soil conservation technology. An entire lesson was designed to demonstrate the technology integrated into precision soil conservation. LiDAR, the most up-to-date technology used in precision soil conservation measurement, was a primary component of this lesson. The lesson content should be reviewed in order to determine why students did not grasp the advantage of LiDAR over other precision soil conservation technologies. Due to such a low score on both pre- and post-content knowledge assessments, it may be necessary to analyze the test question for misleading or ambiguous answer choices. Buman (2013) stated that "conservation technology offers the best opportunity for conservation planning to be integrated with production agriculture" (p. 96A). In order for sustainable agriculture curriculum to remain up-to-date, it is important that the most up-to-date technology be in full focus when developing soil and water conservation curriculum.

Though the perception statements regarding specific conservation practices showed stronger agreement after curriculum implementation, the content question regarding conservation practices was missed more often on the post-content knowledge assessment than it was on the pre-content knowledge assessment. In this situation, the students demonstrated an understanding of the importance of structural and operational conservation practices, but they were not able to connect the differences between the two in content knowledge application. The curriculum proved to have delivered the importance of conservation practices in general, but this specific lesson content should be emphasized in order to guide students in understanding the difference between the two conservation practices.

Students did not grasp the concept that phosphorus was a serious concern when considering water quality. This concept was identified through two items (identify phosphorous as the soil erosion nutrient and explain phosphates in water sources) and were the most missed questions on the post-content knowledge assessment. When reviewing the final content scores, it appears that students may have chosen the correct answer by random chance on the pre-content knowledge assessment and the post-content knowledge assessment showed a decrease in students who correctly answered the question. When the perception statement regarding the phosphorus cycle is taken into account, there was only a moderate increase in agreement, perhaps giving reason as to why students did not make a connection between the phosphorus cycle and phosphorus being considered the soil erosion nutrient. As Jacobson, David, and

Drinkwater (2011) noted, Iowa has been a critical player in contributing to high amounts of phosphorus in the Northern Gulf of Mexico, showing how important it is that our local students understand the impact of phosphorus on the environment. Therefore, this component of the lesson should be revised as one of the most important aspects of the curriculum that the students needed to understand.

Understanding soil erosion may appear as a daunting task for high school students. They may feel that it would be very difficult to make a difference given the multitude of challenges of soil erosion presented in the curriculum. Until the students are able to apply and share what they have learned, they undoubtedly may feel unable to make an impact on soil erosion, thus the reason for students' showing only slight increase in attitudes towards this objective.

Though it was encouraging to see a six point increase in the average pre- and post-content assessments, sixteen out of twenty three questions would be considered a 70% at the high school level, tallying to be a low 'C' or high 'D' grade. A potential explanation could be associated with how well the information was received by the students and whether or not the curriculum was too difficult for their level of understanding. "Given the evolution of the concept of agricultural literacy and recent changes in society, the need for revision becomes more meaningful to keep up with changes in school curriculum" (Powell & Agnew, 2011, p. 166). Continual revision will make this curriculum even more relevant and applicable reaching many more students in a wider array of communities, helping to promote agricultural literacy and the importance of precision soil conservation in society.

Implications and Recommendations

Teachers often adapt materials to meet the needs of their students, creating a gap between the curriculum developers' intentions and what the students actually gain from the lessons (Ball & Cohen, 1996). "Developers' designs thus turn out to be ingredients in—not determinants of—the actual curriculum" (Ball & Cohen, 1996, p. 6). If the researchers are able to truly understand the teachers' perspective, valuable feedback will be ample for future development of precision soil conservation curriculum. Teacher feedback, as suggested by the Food and Agriculture Organization of the United Nations (2013), would indicate how lessons were changed based upon the previous knowledge of the students. As researchers aiming to improve the curriculum, it is important to consider changes that may have been made by the teachers that either diluted the content or added richness. This feedback is needed to make further changes and adaptions to the curriculum before it is released statewide. However, careful consideration needs to be taken into account that students may react differently to certain methods and activities that may have been adjusted upon implementation by the teacher. It is important to gain the teachers' perception of the curriculum development and implementation process. If the teachers changed specific components of the curriculum, to meet varying course contexts, this may provide reasoning for the data presented in this study.

Agricultural educators are being expected to teach curriculum that has greater emphasis on content (Parr, Edwards, & Leising, 2006; Nolin & Parr, 2013), specifically curriculum that meet science and mathematics standards (Myers & Dyers, 2004). The precision soil conservation curriculum focused heavily on science and math principals. Considering the average age of the students, the agricultural educators successfully taught the USLE equation which required some upper level math skills. However, for future studies, it would be beneficial to collect internal assignments from the teachers to determine, specifically, the comprehension of the USLE equation and other science content knowledge. Quizzes and activities throughout the curriculum were not collected in this study, but would benefit future studies in order to determine the growth that students achieved throughout the comprehensive lessons.

“The successful implementation of a curriculum demands that teachers be provided with the resources that the curriculum requires including specialized materials and in-service training to upgrade knowledge” (Agbaje, 1998). The adoption of new curriculum often receives concern as to whether or not it will be implemented in the manner intended, which is why training sessions are often necessary (Ball & Cohen, 1996). A two-day training is all that was required for the teacher-trainers in this study. It is suggested that more time be set aside to train the teachers in the content and activities involved in a new curriculum. Based upon the needs assessment, it can easily be determined whether or not the teacher has requisite content knowledge background in content areas such as precision soil conservation. The less knowledge the teacher has in the content, the more time that should be spent developing the materials and content around what the teacher feels comfortable teaching.

When considering the model adapted from Food and Agriculture Organization of the United Nations (2013), a critical element in the model is the relationship between the curriculum development team and the initial implementers of the curriculum. At the earliest stages, it is imperative that the development team asks for the thoughts and perspectives of the teachers who will implement the developing curriculum. The following questions will give the development team direct feedback from the implementing teachers before the curriculum has ever begun: “Is this curriculum implementation realistic in the time frame that is allotted?”; “Can the students at the high school level gain from the content and methods that are infused in this curriculum?”; “What suggestions might there be to make the curriculum more user-friendly and student-centered?”; and most importantly, “Will the students perceive the curriculum to be relevant to them? If not, how can the perceived relevance be improved?”.

It should be acknowledged that many conditions and circumstances must align in order for this curriculum model to succeed in agricultural education. New curriculum cannot be placed in any situation and be expected to work. Student influences, teacher knowledge of instructional design, environment, and views of community and policy must all be taken into consideration before designing curriculum (Ball & Cohen, 1996). Though the flow of development in the model traces from evaluation all the way back to the planning phase, it would not be necessary to repeat the planning phase if these components still work as a part of the curriculum. However, with the constant change occurring in sustainable agriculture and the technology involved in the agriculture sector, it may be necessary to redirect the flow of any component of The Curriculum Development Process or any other curriculum development conceptual frameworks.

It is recommended that additional student data be collected after statewide implementation of the curriculum to ensure the results gained from this study. A larger sample size may ensure the validity of the content in the curriculum and determine the impact the curriculum is making on students’ perceptions and content knowledge of soil and water conservation. A larger sample size would also allow researchers to determine the differences in content knowledge by grade, FFA membership, and other demographic variables. Evaluating the results by demographics may lead to further inquiries. Researchers could determine whether or not soil and water conservation content is being covered in grade-level required science courses, in turn having an effect on students’ pre-content knowledge assessment scores prior to curriculum implementation.

Due to the convenience sampling method utilized in this study, results should not be generalized to all agricultural education departments in Iowa. However, this study may provide important findings that can be used in the development of other curricula in agricultural education. The Curriculum Development Process (Food and Agriculture Organization of the United Nations, 2013) or other curriculum development guides (e.g., Ball & Cohen, 1996) are essential in developing a product that not only works to increase agricultural literacy, but also implements new pedagogical approaches and materials for the teachers involved.

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