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(Agricultural Literacy)
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Utilizing Facebook to Disseminate Horticultural Lessons to Adults

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Utilizing Facebook to Disseminate Horticultural Lessons to Adults

Abstract

Social media has an impact on how many Americans go about their daily lives. Over 800 million people have Facebook accounts and 50% of users log into the site each day. Facebook has been used in formal education environments to supplement traditional delivery methods and improve learning. Agricultural education researchers have studied the use of Facebook as a part of formal coursework. A quantitative content analysis was implemented for one year on the [State] Master Gardener Facebook page in order to analyze the educational lessons, formats of the lessons, and clientele questions. Eighty-one lessons were disseminated, landscaping (n = 21) was the most delivered subject, (n = 46) lessons were linked to websites, and information on landscaping received the most questions from clients (n= 62). Videos, websites, and fact sheets were included on the Facebook page as examples of where constituents could acquire more information on the topic. Given the amount of time adults spend on Facebook, the social media tool provides an important opportunity to provide information to more clients and at a relatively low cost. Future research should assist Master Gardener coordinators in developing a better understanding of approaches to enhance participant learning with social media. Other Extension programs may expand clientele by offering information on social media that can be accessed by adults via smartphones or tablet devices anytime, anyplace, and at their convenience. State Master Gardener programs should consider offering a Facebook page in order to improve educational communications and collaborations with participants, offer clientele valuable learning experiences, and expand the reach of the program's products with other adults.

Introduction

The demand for instantly accessible information has grown rapidly along with the development and advancement of technology. Social media tools have a profound impact on how adults conduct business (Robin, 2008). Facebook is a social media tool that increases social capital by developing new contacts with the intent of sharing information (Burgess, 2009). Roblyer et al. (2010) noted that Facebook was a valuable resource to improve educational communications and collaborations. Facebook currently has more than 500 million active users, with over 50% of those users logging in on a daily basis (Van Grove, 2010). Idris and Wang (2009) reported Facebook supported innovative learning methods, cultivated student engagement, encouraged use of current multimedia materials, and facilitated student reflection in a study of course content delivered by Web 2.0 tools (Idris & Wang, 2009). Facebook has the ability to displace other Virtual Learning Environments (VLE) through continued program development (Severence, Hardin, & Whyte, 2008).

Facebook has been used to supplement and enhance learning in educational environments. Baran (2010) found that 84% of students enrolled in a distance education course believed that Facebook could be used for "knowledge-sharing in formal education contexts" (p. 2) and that being able to communicate with their peers enrolled in the class helped to trigger their learning. In a study of Facebook use as communication and learning tool for a teaching cohort, English and Duncan-Howell (2008) reported that students found the group to be useful for "encouragement and support" (p. 600), by building a sense of community amongst the group, although students were based at different locations.

The use of Facebook on mobile devices is an intriguing and increasingly common trend within university systems. Oregon State University uses Facebook to deliver horticultural information to a variety of learners from diverse locations, including learners living abroad (Langellotto-Rhodaback, 2010). In Minnesota, participants of online Master Gardener courses spent 22% more time on course work than traditional classroom participants and found the use of online discussion lists a “valuable learning experience” (Jeannette & Meyer, 2002, p. 155).

The Master Gardner program is a major educational initiative of Cooperative Extension. Master Gardeners are individuals taught and trained by Extension faculty to deliver horticultural information to local constituents (Meyer et al., 2010). Approximately 3,900 [State] Master Gardeners taught approximately 65,000 of the [State’s] 18 million citizens in 2009. Strong and Harder (2010) suggested Master Gardener coordinators may benefit from innovative delivery strategies designed to deliver educational programs to a broader group of stakeholders. Extension should expand their audience by providing unique delivery methods to targeted clientele (Loibl, Diekman, & Batte, 2010). Facebook is an innovative educational delivery tool that may expand Extension’s clientele.

Agricultural education academics have conducted research on students’ use of Facebook. Rhoades, Irani, Telg, and Myers (2008) reported approximately 85% of college of agriculture students at the University of Florida had a Facebook account. Roberts, Murphy, and Edgar (2010) utilized Facebook to assess Texas A&M University student teachers during their student teaching experience. In a study of agricultural education students’ selected social media, Rucker, Naile, and Ray (2010) recommended instructors integrate social media into course curricula for the opportunity to improve student learning. However, little research exists on the use of Facebook to disseminate agricultural education information to adults outside the classroom. This study was conducted to address the *National Research Agenda’s* recommendation that research is needed to examine appropriate delivery systems for nonformal agricultural extension audiences (Osborne, n. d.).

Theoretical Framework

This study was framed by Gagné’s (1985) conditions of learning theory. Gagné (1985) identified nine techniques for designing instructional strategies to be an effective educator. The nine conditions of learning perspective are often referred to as conditions of learning or principles of cognitive learning. Educators should learn methods to enhance participant learning (Gagné, 1985). Merrill (2002) said the nine learning principles center on developing the learner’s capacity and skills to acquire information at a more rapid pace.

An educator should gain the attention of the learner at the beginning (Gagné, 1985). This principle informs the learner regarding the topic that will be covered. The second step is to inform the participant of the learning objectives. This condition motivates the learner to focus on the lesson’s expectations and the material that will be included. Stimulating recall of prior learning allows the learner to bridge personal experiences with new knowledge. An educator should provide stimuli to emphasize active learning methods that assist the learner in retaining new knowledge and promoting critical thinking and problem solving. Including discussions and interactive information in collaborative learning environments fosters learning guidance from the educator. An educator should elicit performance to examine whether the learner has acquired the respective competency. This feature motivates the learner to be more self-directed. Providing feedback aids the educator in determining whether the learning objective can be consistently executed. An educator should assess the performance of learners routinely in an informal manner. Creating experiences that enable adults to generalize the information to their personal situation is vital for educators (Gagné, 1985). This will increase the likelihood learners will transfer the information to their current lifestyle.

Gagné's (1985) nine conditions of learning have been used in a variety of studies involving technology instructional environments. Studies have utilized the nine conditions of learning to assess the design and development of educational technology programs in other countries (Fresen, 2007; Liu, 2008). The nine conditions of learning were used to measure instructional immediacy and design in web-based courses (Hutchins, 2003; Koohang & du Plessis, 2004)). Gagné's (1985) Studies have used the nine conditions of learning to evaluate student learning in web-based educational programs (Janicki & Liegle, 2001; Kidney & Puckett, 2003). The nine conditions of learning were utilized as the theoretical framework to measure the design quality and participant learning in technology based courses (Duebel, 2000; Moallem, 2001). Dooley, Lindner, and Dooley (2005) suggested the nine conditions of learning are effective methods for distance educators to plan instructional delivery.

Purpose and Objectives

The purpose of this study was to examine if the [State] Master Gardener Facebook page could be utilized as a nonformal education delivery system. More specifically, the study sought to:

1. Describe the topics and number of lessons on the Facebook page,
2. Describe the delivery method and number of responses of each educational lesson and;
3. Determine if the nine conditions of learning were in the horticultural lessons.

Methodology

The [State] Master Gardener Facebook page was examined from November 3, 2009, the public release date, to June 3, 2011 through the implementation of a quantitative content analysis to address the research objectives. A quantitative content analysis allows a researcher to systematically quantify data and is valuable in analyzing observational data (Riffe, Lacy, & Fico, 2005). This type of analysis enables the researcher to formulate themes that assist in understanding categories for large amounts of data (Fraenkel & Wallen, 2009). There are four advantages of content analysis in social science research. The major advantage of content analysis is the method is not obtrusive. Information can be assessed without the author or publisher being aware of the analysis (Fraenkel & Wallen, 2009). The second advantage of quantitative content analysis is the method provides a means of analyzing observational data (Riffe et al., 2005). Data can be in a newspaper, on television, or on a web site. The third advantage allows the researcher to sift through documents and records in order to gain an understanding of the social phenomena. The fourth advantage of a quantitative content analysis is time. Information that is readily available does not require a great deal of time and money to analyze (Fraenkel & Wallen, 2009). A commonly used approach to interpret data in a quantitative content analysis is to calculate frequencies and the proportion of specific amounts compared to whole amounts (Riffe et al., 2005).

A quantitative content analysis has techniques to address validity and reliability for social science research. Face and construct validity of the study were assessed by a team of horticultural researchers and educators at [State] University. Valid constructs enable researchers to apply theory to a quantitative content analysis (Riffe et al., 2005). In this study, coders were used to identify the groupings in order to assist in addressing reliability and apply those definitions to the content being analyzed, as recommended by Riffe et al. (2005). Gagne's (1985) nine conditions of learning were used by the researchers to create defined groupings used to address reliability in this study. The nine conditions of learning were the groupings used to address reliability.

Intercoder reliability is the degree independent coders assess the characteristic of a message and make identical conclusions (Fraenkel & Wallen, 2009). Riffe et al. (2005) indicated addressing intercoder reliability is a critical facet of content analysis. The researchers measured intercoder reliability of the topics on the [State] Master Gardener Facebook page through the implementation of Cohen's kappa (k). Agresti and Finlay (2009) recommended Cohen's kappa as the most robust approach to assess intercoder reliability. Cohen's kappa is calculated as $k = \Pr(a) - \Pr(e) \div 1 - \Pr(e)$. $\Pr(a)$ is the comparative observed agreement between raters. The hypothetical probability of chance agreement is $\Pr(e)$. When raters are in complete agreement, then $k = 1$, and when no agreement exists, then $k = 0$ (Cohen, 1968). The researchers used SPSS 18.0™ to calculate the Cohen's kappa in order to answer the study's third objective: to examine if the horticultural lessons contained the nine conditions of learning. Each of Gagné's (1985) nine conditions of learning was calculated, using Cohen's kappa, with the ten horticultural topics found on the [State] Master Gardener page (see Table 1). According to Cohen (1968) when implementing Cohen's kappa, coefficients of .80 or greater are acceptable in research. The researchers organized results from the study into topics, educational lessons, format of each educational lesson, and the number of questions received from clientele based on the topic.

Table 1
Reliability of the Nine Events of Learning between the Horticultural Topics on Facebook

Condition of Learning	***k***
Gain attention	.96
Informing learner of the learning objective	.92
Stimulating recall of prior learning	.88
Provide stimuli to emphasize active learning methods	.86
Learning guidance from the educator	.83
Elicit performance	.83
Provide feedback	.81
Assess performance	.76
Generalize	.72

Note: Reliability coefficient of .80 or higher were considered acceptable (Cohen, 1968).

Findings

Findings were organized by the topic, educational lessons, formats of the lessons, and the number of clientele questions per topic within that topic over a twenty month period. The limitations of the study were the target population and delivery tool. The results should not be generalized to all Master Gardener programs or other nonformal educational programs on Facebook. The first objective of the study was to examine the number of educational lessons and describe the topics on the Master Gardener Facebook page (see Table 2). A total of 81 different lessons were delivered on Facebook. A variety of horticultural educational topics were delivered on Facebook. Landscaping (n = 21), Insects (n = 12), and newsletters (n = 12) were the most delivered topics. Newsletters were a topic created by the researchers and were delivered monthly on the Facebook page. Safety (n = 3) was the least delivered topic on the [State] Master Gardener Facebook page.

Table 2
Distribution of Topics and Numbers of [State] Master Gardener Facebook Lessons

Topic	**Lessons (*f*)**	**Percentage of Sample**
Landscaping	21	25.9%
Insects	12	14.8%
Newsletters	12	14.8%
Flowers	9	11.1%
Vegetables	6	6.2%
Fruits	5	6.1%
Plants	5	6.1%
Soil	4	4.9%
Animals	4	4.9%
Safety	3	3.7%

Note: The topics and quantities were examined from November 3, 2009 to June 3, 2011.

The study's second objective was to describe the delivery method and number of responses of each identified educational lesson on Facebook (see Table 3). There were (n = 46) Master Gardener lessons linked to websites, (n = 51) lessons were informational fact sheets, and (n = 6) lessons provided video demonstrations. Landscaping (n = 62) and insects (n = 54) received the most questions from clientele. The State Master Gardener Coordinator's office responded to each of the questions submitted on the Facebook page.

Table 3

Topics, Delivery Method and Number of Questions for Master Gardener Facebook Lessons

	Method of Delivery (*f*)			Responses(*f*)
Topic	**Video**	**Website**	**Text**	**Questions**
Landscaping	5	11	8	62
Insects	1	11	14	54
Newsletters	0	1	12	35
Flowers	0	5	5	35
Fruits	0	3	2	27
Vegetables	0	3	3	20
Plants	0	5	1	14
Soils	0	4	1	16
Animals	0	2	3	26
Safety	0	1	2	9

Note: The lessons were examined from November 3, 2009 to June 3, 2011.

The third objective of the study was to examine if the horticultural lessons contained Gagné's (1985) nine conditions of learning (see Table 4). Each lesson incorporated at least one of the nine conditions of learning. All lessons (N = 81) gained the participant's attention and informed the participant of the learning objective. Very few (n = 3, 3.70%) of the 81 educational lessons provided feedback, assessed the performance of participants, or generalized the information to their lives.

Table 4

Examining the Horticultural Lessons with the Nine Conditions of Learning (N = 81)

Conditions of Learning	***f***	**%**
Gain Attention	81	100
Informing learner of the learning objective	81	100
Stimulating recall of prior learning	52	64.1
Provide stimuli to emphasize active learning methods	49	60.4
Learning guidance from the educator	32	39.5
Elicit performance	30	37.1
Provide feedback	3	3.7
Assess performance	3	3.7
Generalize	3	3.7

Note: The lessons were examined from November 3, 2009 to June 3, 2011.

Conclusions/Implications/Recommendations

Landscaping was the most popular topic on Facebook. Insects were also commonly discussed on the [State] Master Gardeners program page on Facebook. A variety of both beneficial and harmful insects were described. The Safety category included lessons on heat safety and the Gulf of Mexico oil spill. Safety is not typically considered a horticultural topic. The majority of educational lessons did not include the nine conditions of learning. Facebook administrators did utilize videos, websites, and fact sheets as examples where constituents could acquire more information on the topic. Facebook was used as an outlet to deliver *The Neighborhood Gardener*, the monthly [State] Master Gardeners newsletter.

Selected topics were delivered with the time of year in mind, as Gagné (1985) recommends. The Master Gardener lessons on Facebook gained the attention (Gagné, 1985) of friends of the page because each lesson was related to the growing season or a current environmental concern. Not all lessons informed participants of the learning objective. Including a learning objective encourages a student to concentrate on the material that will be covered (Gagné, 1985). Each lesson did not connect a client's personal experiences with new horticultural knowledge. Gagné's (1985) research indicated stimulating a memory of past learning allows the learner to channel personal experiences with new information.

The comments sections provided clients with a collaborative learning environment to communicate with one another and the coordinator. Gagné (1985) said incorporating discussions in cooperative learning environments cultivates learning guidance from the instructor. The lessons on the Facebook page did not include an evaluation component to measure if friends had learned new information or changed their current practice as a result of participating in the Master Gardener lessons on Facebook. Gagné (1985) said educators should measure student's performance to develop an understanding of the competencies acquired. The coordinator cannot be sure which client and how many viewers gained knowledge to further develop the capacity and skills to learn information more effectively. An instructor should evaluate the accomplishments of students regularly (Gagné, 1985). The Facebook Master Gardener lessons constructed opportunities and experiences, through websites, fact sheets, and videos that enabled clientele to generalize the content. This aspect enhanced the likelihood clientele transferred the Facebook information to their current gardening situation (Gagné, 1985).

The results presented here add to the current literature and offer practitioners techniques to broaden the reach of Extension's educational efforts. Facebook was found to deliver educational content to constituents. Information on Facebook can be accessed by smartphones or tablet devices and not solely through desktop computers. Delivering educational content on Facebook to a target audience was an innovative educational approach to offer specific information to adults at their convenience. Other Extension programs could offer information on Facebook, Twitter, or other social media platforms accessed conveniently by adults via smartphones or tablet devices at any time or place.

Future research should assist Master Gardener coordinators in developing a better understanding of approaches to enhance participant learning with social media. This study framed the research around Gagné's (1985) nine conditions of learning. Bloom's (1956) taxonomy of learning domains would be another theoretical approach to assist Master Gardener coordinators better comprehend how to improve participant learning through educational content on Facebook. Incorporating Blumler and Katz's (1974) uses and gratifications theory could assist in identifying whether the Master Gardener Facebook page to fulfills client's needs.

Master Gardener coordinators should include all nine of Gagné's (1985) conditions in horticultural educational lessons on Facebook in order to increase the likelihood that maximum learning outcomes will be produced. Professional development efforts from Extension Systems can improve program coordinators' knowledge and skills of approaches to improve clientele learning. Teaching Master Gardener coordinators the nine conditions of learning, the taxonomy of learning, and the fundamentals of uses and gratifications could be achieved through face-to-face instruction, web-based learning modules, or videoconferencing systems.

Given the amount of time adults spend on Facebook (Van Grove, 2010); the social media tool provides an important opportunity to provide information to more clients and at a relatively low cost. Including newsletters on a Facebook page decreases the costs associated with printing and mailing newsletters to participants. Due to the relative ease of creating a Facebook page with educational content and given the current state of financial budgets, Master Gardener and Extension programs should examine offering newsletters on Facebook as an approach to decrease costs and expand viewership.

In this study, not all clientele of the [State] Master Gardener Facebook page were certified Master Gardeners. This indicates the goals and educational information of Master Gardener can be expanded to larger audiences outside of program coordinators, volunteer educators, and clientele. Other state Master Gardener programs should consider offering a Facebook page in order to improve educational communications and collaborations (Roblyer et al., 2010) with participants, offer clientele valuable learning experiences (Jeannette & Meyer, 2002), and expand the reach of the program's products with other adults, as recommended by Strong and Harder (2010).

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An Evaluation of the Alabama FFA Agricultural Mechanics Career Development Event to Determine Represented Mathematical Competencies - An Analysis of Curriculum Alignment

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An Evaluation of the Alabama FFA Agricultural Mechanics Career Development Event to Determine Represented Mathematical Competencies - An Analysis of Curriculum Alignment

Abstract

This study sought to discover what specific math skills from the Alabama mathematics curriculum have been previously embedded within selected activities from the Alabama State FFA Agricultural Mechanics Career Development Event (CDE). Leedy and Ormrod's (2005) content analysis method was used to evaluate both the 2009 Alabama Course of Study: Mathematics and selected activities from the Alabama State FFA Agricultural Mechanics CDE. It was discovered by the researchers and verified by an Alabama mathematics specialist that a total of twenty-seven mathematics curriculum standards were indeed represented by the contest activity requirements. Upon these findings, the conclusion reached within this study was the determination of an assortment of various mathematics skills that should be learned, understood, and retained by student participants and their agriculture teachers in preparation for participation in the Alabama State FFA Agricultural Mechanics CDE. Agriculture teachers are encouraged to work with mathematics teachers in their schools to develop a math-enhanced agricultural mechanics curriculum. Instruction through a math-enhanced agricultural mechanics curriculum could possibly result in increasing both agriculture teachers' and students' understanding of mathematical applications in agriculture. Enhanced understanding of various mathematical applications could potentially result in higher contest scores.

Introduction & Conceptual Framework

Criticism of the public education system has been documented (National Center for Education Statistics, 2010; Norton, Barlow, Prout, & Bidwell, 1998). Many critics believe that students often lack preparation to perform many workplace tasks that require skills in problem-solving and critical thinking (Norton et al., 1998). Moreover, studies have shown that students in many traditional secondary classrooms often lack opportunities in which to apply knowledge gained within an academic classroom to real-world situations (Grubb, Davis, Lum, Philhal, & Morgaine, 1991). However, a potential solution to these persistent issues may exist within the education reform technique of contextualized learning (Parnell, 1996; Parr, 2004; Young, 2006). Previous research (Parr, 2004; Parr, Edwards, & Leising, 2006; Parr, Edwards, & Leising, 2008; Parr, Edwards, & Leising, 2009; Young, 2006; Stone III, Alfeld, Pearson, Lewis, & Jensen, 2005; Stone III, Alfeld, Pearson, Lewis, & Jensen, 2006) has indicated that positive gains in student achievement have resulted from career and technical (CTE) educators' efforts in academic integration. Additionally, CTE students have reported that there are indeed tangible benefits to academic integration within CTE classrooms (Conroy & Walker, 2000).

The significance of contextualized learning and teaching has been an important topic in the field of agricultural education for several years. As evidence of this importance, the National Research Council (NRC) (1988) published the book *Understanding Agriculture: New Directions for Education* in order to bring greater transparency and recognition to the topic which ultimately has served as a guide to bring agricultural education into a more relevant state for the 21st century. A portion of what the report called for was the integration of scientific concepts into the secondary agricultural education curriculum in a way that provided basic fundamental education in the sciences while providing a practical, hands-on application in the context of agriculture. Furthermore, the book called for and described the necessary changes to be made to the vocational agriculture [now agricultural education] curriculum to reflect a greater emphasis on scientific concepts within agriculture. The authors called for a move from instruction in traditional production agriculture and into a much more in-depth look at agriculture from a scientific perspective. What was recommended and ultimately resulted from this perspective was the integration of more academic concepts into the agricultural education curriculum at large. Additionally, a new term was created to describe and reflect this integration - agriscience. Although this term is now used to represent multiple applications within the field, it is generally accepted that it reflects the notion that agricultural education has made a shift from a vocational training ground to a more scientific application of concepts in the context of agriculture, natural resources, and the fiber industry (Peasley & Henderson, 1992). Consequently, subsequent years brought about other name changes that removed the vocational emphasis from agricultural education, such as the FFA's name change in 1988 "from Future Farmers of America to the National FFA Organization" (FFA, n. d., ¶ 12).

As decades have passed, the educational process has become better understood and utilized in secondary classrooms throughout America. This was summarized by Yager (n. d.) as the author stated that "Since the mid - 1980s, we have learned more about learning. We now know that most students do not learn what teachers teach. Instead they retain explanations personally constructed to account for phenomena in the rational universe" (¶ 7). Further, in 1994, Romberg stated that the retention of academic material by students is increased whenever the subject material is given within a recognized context. In 1998, Bailey ascertained that familiar concepts, such as agricultural education, can serve as an opportunity for contextualized learning and teaching:

> Agriculturally based activities, such as 4H and Future Farmers of America [, now FFA,] have for many years used the farm setting and students' interests in farming to teach a variety of skills. It only takes a little imagination to think of how to use the social, economic, and scientific bases of agriculture to motivate and illustrate skills and knowledge from all of the academic disciplines. (p. 27).

In addition, utilizing agricultural education as a context for academic integration has resulted in enhanced student understanding of academic material, as documented by previous research (Parr, 2004; Young, 2006; Parr, Edwards, & Leising, 2009; Young, Edwards, & Leising, 2009). Concomitantly, research has indicated that the integration of academic material into CTE classrooms has had no negative effects on students' grasp of CTE coursework (Parr, 2004; Parr, Edwards, & Leising, 2006; Young, 2006; Young, Edwards, & Leising, 2009).

Agricultural mechanics has been cited as a prime curriculum within which to implement contextualized mathematics instruction in a real-world setting (Parr, 2004; Young, 2006). Edney and Murphy (2010) discovered that the implementation of math-enhanced "enrichment activities" (p. 5) in preparing students for participation in the Texas State FFA Agricultural

Mechanics CDE resulted in “improved CDE scores and mathematics achievement” (p. 1). The potential for increased mathematics concept education and integration could lie within the Alabama State FFA Agricultural Mechanics CDE as well. Participation in the Alabama Agricultural Mechanics CDE requires enrollment in grades ranging from seven through twelve. The CDE is designed to complement agricultural mechanics classroom and laboratory instruction and is arranged in the following format: five individual skill development/problem solving activities, one team activity, and one written examination (Alabama FFA Association, 2009). This type of format coupled with the inherent mathematics basis of its adjoining agricultural curriculum could provide an ability to maximize the potential integration of mathematics concepts within a competitive, practical context.

In addition to the recognition of the need to more fully implement an integrated approach to teaching and learning agriculture to include core content areas such as science and math, other factors began to develop within the mathematics education community to provide momentum for this movement. The National Council of Teachers of Mathematics (NCTM) voiced its support for the contextualized learning and teaching of mathematics that very possibly could be taught through the context of agricultural education. According to Kahle (1998), the council has concluded that a successful mathematics education ought to sow into students a deeper-embedded perception of the value of math as a result of their teaching. In 2011, the NCTM stated that “The opportunity to experience mathematics in context is important. Students should connect mathematical concepts to their daily lives,…” (Connections section, ¶ 3). Recent secondary mathematics education literature also proposes that a movement toward the reformation of mathematics education in the form of contextualized learning and teaching may be in progress (NCTM, 2011; Romberg & Kaput, 1999; Kahle, 1998; Bailey, 1998; Bickmore-Brand, 1993; Yager, n.d.).

The need for increased student achievement in secondary mathematics in the United States is well established. The National Assessment of Educational Progress (NAEP) reported that in the year 2009, 36% of 12th grade students performed at a “Below Basic” level on the math portion of their assessment. What is more, 71% of students performed at a level lower than “Proficient” (National Center for Education Statistics, 2010, p. 26). The need for improved student performance in mathematics is acutely apparent in the state of Alabama. The National Center for Education Statistics (2009) reported that 42% of the eighth graders in the state scored at a “Below Basic” level in mathematics in 2009. Further, 80% of the eighth graders in the state scored at a level lower than “Proficient” (p. 1). These results possibly indicate that traditional mathematics education methods may not be providing students with an appropriate level of cognitive development that can be utilized beyond the classroom (Stone III et al., 2006). Also, data such as this indicate that in order to improve student achievement in mathematics, changes must take place in the methodology for mathematics instruction and application at the secondary level. Perhaps agriculture classrooms can help to provide the necessary changes in context, methodology, and results in student mathematics achievement (Parr, 2004; Young, 2006; Conroy & Walker, 2000).

Objectives & Research Question

Agricultural mechanics curricula have been demonstrated to provide a variety of opportunities for both hands-on and minds-on learning (Parr, 2004). What is more, as demands for increased academic proficiency and concept application have increased, secondary agricultural mechanics coursework has been deemed an appropriate vehicle for mathematics concept integration and application (Young, 2006). With possible changes in context for mathematics education, as well as the lack of performance on the parts of students, the researchers' posit was this: To what extent has the FFA Agricultural Mechanics CDE served as a practical, real-world context for mathematics education and application in Alabama? To help address this question, the following objectives for this study were established::

1. Locate, list, and confirm the 2009 Alabama Course of Study: Mathematics content standards embedded within selected FFA Agricultural Mechanics CDE contest activities.

2. Provide a practical and specific list of mathematics concepts that should be integrated within secondary agricultural mechanics technical subject matter.

Procedures

This study utilized an approach consisting of an analysis of both the 2009 Alabama Course of Study: Mathematics and selected activities within the Alabama State FFA Agricultural Mechanics CDE from the years of 2008, 2009, and 2010. Furthermore, Leedy and Ormrod (2005) have classified the procedure as a content analysis, which is defined as "a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases" (p. 108). In keeping with the content analysis procedure, the first step (p. 142) was to recognize the works to be evaluated, which in this case were the aforementioned mathematics course of study and the appropriate Agricultural Mechanics CDE materials. Next, the traits of each document to be examined were distinctly selected and supporting examples were located (p. 142).

To initiate the second step, the researchers contacted the Alabama State FFA Agricultural Mechanics CDE superintendent and requested documentation of all contest activities from the years of 2008, 2009, and 2010. These activities represented the contest's composite portions of participants applying practical knowledge to complete hands-on skill sets, a written examination, and a team activity consisting of various problem-solving situations. After receipt of these materials, both researchers conducted a thorough examination of both the mathematics course of study and the selected contest activities to determine the various mathematics skills that students needed to accurately complete each selected activity. Each activity was selected based on the researchers' posit that mathematics competency is required to solve these selected problems. Due to student participant grade requirements, only mathematics standards from grades seven through twelve were evaluated for possible inclusion (Alabama FFA Association, 2009). These efforts resulted in an initial list of example activities and the twenty-four mathematics concepts represented within the selected contest activities.

To follow the third step of the content analysis procedure (p. 142), the researchers compiled the subsequent composition of the materials into sections to be examined individually by a(n) Alabama mathematics specialist. Additionally, the researchers compiled the initial data set into the following format: mathematics class title, grade level(s), mathematics curriculum standard, and example problem(s).

After the compilation of the data, the researchers followed the final portion of Leedy and Ormrod's procedure set, in which dissection of the data for examples of each occurring trait found in the second step took place (p. 142). To accomplish this final step, the data set was presented to a mathematics education specialist within the state of Alabama, who evaluated the discovered mathematics curriculum standards and the corresponding sample problems to determine whether there was indeed curriculum alignment. Additionally, the mathematics education specialist was asked to notify the researchers of any ambiguity within the data set as well as determine if any portions of the contest activity material did not align with the mathematics curriculum standards.

The mathematics education specialist was recognized as an expert in secondary mathematics education by a faculty member at [University] University and was thus an ideal medium through which to verify, correct, and critique the researchers' methods and findings. The selected mathematics education specialist had previous experience teaching mathematics courses ranging from grades seven to twelve. The mathematics education specialist was asked to carefully screen each selected contest activity and the aligned mathematics competencies reported by the researchers. To accomplish this, the mathematics education specialist was provided the first draft data set composed by the researchers. To evaluate the data set and ensure its validity, the education specialist compared the representations of each selected contest activity to the 2009 [State] Course of Study: Mathematics. During the evaluation process, the education specialist noted where definitive curriculum alignment between agricultural mechanics activities and mathematics competencies did and did not occur (D. Peppers, Personal communication, December 30, 2010) As a result, validity to the researchers' methods and findings were established through a third-party mathematics curriculum expert.

Results

Upon further review by the mathematics education specialist, it was noted that twenty-three out of the discovered twenty-four mathematics standards were found to be consistent with the selected Alabama State FFA Agricultural Mechanics CDE activity requirements (D. Peppers, personal communication, December 30, 2010). The math specialist noted that one standard did not fit the appropriate criteria but did suggest that four additional standards should be included within the data set, bringing the total represented math standards to twenty-seven. The researchers complied with the mathematics education specialist's findings and deleted the non-compliant mathematics standard and added the suggested standards.

The final data set given in the table below, which consisted of twenty-seven aligned mathematics standards, indicates a positive link between both the mathematics curriculum and the agricultural mechanics curriculum. Also, it is illustrated here that the Alabama State FFA

Agricultural Mechanics CDE has shown the capacity to serve as a practical and effective vehicle for embedded mathematics education and application in Alabama. In order to provide for more opportunities for academic integration within agriculture classrooms, these mathematics concepts should be further analyzed, utilized, and understood by student participants and their agriculture teachers. Increasing students' and teachers' knowledge of mathematics concepts and applications could result in enhanced performance within the Agricultural Mechanics CDE (Edney & Murphy, 2010).

Table 1. *Mathematics Standards Verified To Be Linked With Agricultural Mechanics CDE Requirements And Competencies.*

Contest Activity	Alabama Mathematics Standards Addressed within Contest Activity
1. The following activity was given as a three-part question and was taken from the 2008 State FFA Agricultural Mechanics CDE Team Activity: When laying out a building, determine its square footage, cubic yards of concrete needed for the given slab depth, and the diagonal length of the building in inches.	1. Solve problems requiring the use of addition, subtraction, multiplication, and division on rational numbers. Grade 7 Mathematics 2. Demonstrate computational fluency with addition, subtraction, multiplication, and division of integers. Grade 7 Mathematics

2. The following activity was given as two separate questions and was taken from the 2010 State FFA Agricultural Mechanics CDE Individual Problem Solving - Concrete Calculation Skill section: The first question asked for a determination of the cubic yards of concrete needed to construct a slab for a building, while the second question asked for a determination of the cubic yards of concrete needed to construct a pier for a building support.	3. Use order of operations to evaluate numerical expressions. Grade 7 Mathematics 4. Solve problems involving circumference and area of circles. Grade 7 Mathematics 5. Determine surface area and volume of rectangular prisms, cylinders, and pyramids. Grade 8 Mathematics 6. Determine the perimeter and area of regular and irregular plane shapes. Grade 8 Mathematics 7. Solve problems algebraically involving area and perimeter of a polygon, area and circumference of a circle, and volume and surface area of right circular cylinders or right rectangular prisms. Grades 9-12 Algebra I
3. The following activity was given as a six-part question and was taken from the 2009 State FFA Agricultural Mechanics CDE Team Activity section: Determine how much of each ingredient is needed to blend a one ton mix of 5-10-15 fertilizer.	8. Solve problems involving rates or ratios, using proportional reasoning. Grade 7 Mathematics 9. Use various strategies and operations to solve problems involving real numbers. Grade 8 Mathematics 10. Applying proportional reasoning to application-based solutions. Grade 8 Mathematics
4. The following activity was given as a three-part question and was taken from the 2010 State FFA Agricultural Mechanics CDE Individual Problem Solving - Rafter Construction Skill section: Given the dimensions of span and slope, determine rise of the roof, rafter length to the nearest 1/16", and draw the appropriate angles and dimensions for the ridge cut.	11. Solve problems using the Pythagorean Theorem. Grade 8 Mathematics 12. Determine measures of special angle pairs, including adjacent, vertical, supplementary, complementary angles, and angles formed by parallel lines cut by a transversal. Grade 8 Mathematics 13. Determine missing information in an application-based situation

	using properties of right triangles, including trigonometric ratios and the Pythagorean Theorem. Grades 9-12 Algebraic Connections 14. Apply proportional reasoning to determine missing lengths of sides, measures of angles, and ratios of perimeters and areas of similar polygons. Grades 9-12 Geometry 15. Apply the Pythagorean Theorem and its converse to solve application problems, including expressing answers in simplified radical form or as decimal approximations and using Pythagorean triples where applicable. Grades 9-12 Geometry 16. Apply properties of special right triangles, including 30-60-90 and 45-45-90 triangles, to find missing side lengths. Grades 9-12 Geometry 17. Utilizing the Pythagorean Theorem to solve application-based problems. Grades 9-12 Algebra I
5. The following activity was given as a five-part question and was taken from the 2010 State FFA Agricultural Mechanics CDE Team Activity section: Provide an analysis to answer questions concerning the use of integrated pest management in sweet corn. These questions concerned data such as percentage of yield, value of net returns, comparisons of values of net returns, determining which chemical(s) provided the most value to producers, and the value of integrated pest management. To determine the answers, competencies in data analysis and comprehension were necessary.	18. Use given and collected data from samples or populations to construct graphs and interpret data. Grade 8 Mathematics 19. Calculate probabilities given data in lists or graphs. Grades 9-12 Algebra I 20. Compare various methods of data reporting, including scatterplots, stem-and-leaf plots, histograms, box-and-whisker plots, and line graphs, to make inferences or predictions. Grades 9-12 Algebra I 21. Use analytical, numerical, and graphical methods to make financial and economic decisions, including those involving banking and invest-

	ments, insurance, personal budgets, credit purchases, recreation, and deceptive and fraudulent pricing and advertising. Grades 9-12 Algebraic Connections 22. Determine approximate rates of change of nonlinear relationships from graphical and numerical data. Grades 9-12 Algebraic Connections 23. Create a model of a set of data by estimating the equation of a curve of best fit from tables of values or scatterplots. Grades 9-12 Algebraic Connections 24. Using multiple representations, including graphical, numerical, analytical, and verbal, to compare characteristics of data gathered from two populations. Grades 9-12 Algebra II with Trigonometry 25. Analyze data to determine if a linear, quadratic, or exponential relationship exists. Grades 9-12 Algebra II with Trigonometry 26. Use multiple representations to, including graphical, numerical, analytical, and verbal, to compare characteristics of data gathered from two populations. Grades 9-12 Algebra II 27. Analyze data to determine if a linear or quadratic relationship exists. Grades 9-12 Algebra II

Conclusions

Upon review of the data, the logical conclusion was that there indeed exists substantial curriculum alignment between the fields of mathematics and agricultural mechanics. What is more, these mathematics skills are often inherently embedded within the secondary agricultural mechanics curriculum. It is interesting to note that fifteen of the twenty-seven math standards come from grades nine through twelve, which implies that higher levels of mathematics education and understanding are required for optimal success in the competition. However, this finding is appropriate, as a majority of the student participants are enrolled in grades nine through twelve. The researchers recommend that each of the activities listed in the above table be implemented into the agricultural mechanics curriculum so that the most opportunities for teaching embedded mathematics may be achieved (Stone III et al., 2006).

Discussion & Implications

This study could serve as a guide to demonstrate yet another area where curriculum integration naturally occurs – the FFA Career Development Event. The information obtained here is supported by previous research (Young, 2006; Young, 2009; Parr, Edwards, & Leising, 2006; Parr, 2004; Conroy & Walker, 2000) that has indicated that not only is curriculum integration between agriculture and mathematics possible, but that such cooperation between the two disciplines can result in potentially higher mathematics achievement and understanding for both students and teachers. However, while many of these mathematics concepts are often inherently present within agricultural mechanics curricula, this fact can be easily overlooked by program stakeholders (Warnick & Thompson, 2007). Therefore, increased communication with education program stakeholders about the applications and effects of mathematics integration within secondary agricultural curricula is desirable (Warnick & Thompson, 2007).

The [State] FFA Agricultural Mechanics CDE and the mathematical competencies that align with selected activities taken from it do provide a practical example of mathematics concept integration. However, while this body of research provides a glimpse of the current and potential levels for mathematics integration within the CDE and its corresponding agricultural curricula, the researchers stress that a relatively small percentage of secondary agricultural education students in [State] do participate in the Agricultural Mechanics CDE. As a result, the possibility exists that not all agricultural education students have the opportunity to experience this variety of practical mathematical applications within in a real-world context. Thus, to provide this level of real-world mathematics application, agriculture teachers are encouraged to implement mathematics concepts within secondary agricultural mechanics coursework.

For those individuals who organize and conduct the Alabama FFA Agricultural Mechanics CDE, perhaps the increased integration of mathematics concepts within the Agricultural Mechanics CDE could provide a meaningful context for mathematics education and application (Edney & Murphy, 2010). Agricultural mechanics curricula have demonstrated excellent potential to serve as an effective vehicle for mathematics education (Parr, 2004; Young, 2006). What is more, as preparation for participation in the Alabama Agricultural Mechanics CDE, perhaps contest organizers could conduct preparation activities that align with both this list of embedded mathematics concepts and Edney and Murphy's methodology (2010).

Further research on the current state of curriculum integration between mathematics and agriculture can help to lead the call for additional education reform within both secondary classrooms and the teacher education program environments. The National Research Council (1988) determined that in order to graduate highly-qualified individuals, secondary agricultural education must remain relevant as well as effective through the teaching of advancements in agriculture as well as a heavier emphasis on academics. In 1995, Newcomb gave his support of this recommendation, as he stated that "The need to have students graduate with the demonstrated capacity to think at the higher levels of Bloom's taxonomy is more urgent than ever. The nature of the world we live in demands it" (p. 4). Furthermore, in order to remain competitive globally, program graduates must be capable of demonstrating increased academic and technical competence (Parr, 2004).

For classroom practice, it is suggested that agriculture teachers as well as their students gain better understanding of mathematics and its applications, procedures, and functions. To help accomplish this, agriculture teachers should be encouraged to establish a practical working relationship with mathematics educators within their schools (Parr, 2004; Stone III et al., 2006). Also, agriculture teachers are advised to implement mathematics education tools and methodologies [e.g., the Math-in-CTE model (Stone III et al., 2006)] into agriculture classes in order to possibly improve students' grasping of mathematics concepts and applications. By increasing competence in mathematics, students could develop a deeper understanding of math applications within agricultural mechanics; therefore, they could possibly be better prepared to participate in the Alabama State FFA Agricultural Mechanics CDE. Ideally, increased agricultural mechanics concept development and contest preparation will yield increased contest scores (Edney & Murphy, 2010).

For professional development, agriculture teachers are advised to participate in development sessions that emphasize academic integration within agriculture classrooms. Moreover, these sessions should be of significant duration, as Garet, Porter, Desimone, Birman, and Yoon (2001) indicated "that sustained and intensive professional development is more likely to have an impact, as reported by teachers, than is shorter professional development" (p. 935). In accordance with their findings, suggestions for teacher professional development include educational workshops in utilizing agriculture as the context for mathematics education to possibly enhance understanding and cooperation between the two disciplines. Also, according to Bickmore-Brand (1993), communication issues have risen in the utilization of differing mathematics terminology between teachers of different disciplines. These issues have often previously resulted in both students and teachers being confused on the proper names of mathematical concepts (Bickmore-Brand, 1993). As a result, there is often a lack of both students' and teachers' understanding of mathematics concepts within agricultural curricula (Parr, 2004). Therefore, professional development workshops should be designed to address terminology differences and issues as well (Bickmore-Brand, 1993; Parr, 2004; Parr, Edwards, & Leising, 2006).

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The Impact of Middle School Agricultural Education Programs as Perceived By Georgia Middle School Principals

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The Impact of Middle School Agricultural Education Programs as Perceived By Georgia Middle School Principals

Abstract

The purpose of this study was to determine Georgia middle school principals' perception of agricultural education. The National Research Agenda for Agricultural Education and Communication set forth a goal to identify strategies that show promise in expanding enrollment in quality agricultural education programs (Osborne, 2007). This goal manifests itself in the state of Georgia by the creation of middle school agricultural education programs. The likelihood of having a quality agricultural education program is increased when administrative support is present (Kalme & Dyer, 2000). This quantitative study examined 33 Georgia middle school principals that have agricultural education programs at their schools. Results indicate that the principals perceive the agricultural education program as being an important part of the school and community; positively impacting a students' performance in both math and science; assisting students in goal setting, problem solving, and respecting others; and providing equal opportunities for all middle school students.

Introduction/Theoretical Framework

Middle grades agricultural education programs are important to the total agricultural education profession because they are often the initial point of contact for students who have an interest in the agricultural industry (Rayfield & Croom, 2010). Benefits of agricultural education, including increased agricultural literacy, responsibility, respect, and speaking ability have been documented (Rossetti, Padill, & McCaslin, 1992). Fritz and Moody (1997) found that respondents that did not have a middle school program implemented at their school would like to implement one. Rayfield and Croom (2007) cited the "10x15" proposal developed by the National Council for Agricultural Education to increase the number of quality agricultural education programs in the United States when they wrote,

> According to the 10 x 15 Long-Range Goal for Agricultural Education, there will be 10,000 quality agricultural education programs that serve students through classroom instruction, supervised agricultural experience, and FFA programs by year 2015. One avenue of potential growth is to create more middle school agricultural education programs (p. 722).

Kantrovich (2007) warned that the National Council's 10 x 15 goal of having 10,000 quality programs by 2015 would be a complicated and difficult one to satisfy. Whether at the urging of the National Council for Agricultural Education or from states seeking to add middle school programs to improve student achievement and programmatic success, it is apparent that more middle school programs of agricultural education are needed. If additional programs are to be established, school administrators must have a positive perception of agricultural education.

Several studies (Hinkson & Kieth, 2000; Kalme & Dyer, 2000) have concluded that administrators generally have a positive attitude and perception toward agricultural education. However, Kalme and Dyer (2000) stated that programs will be limited unless principals continue to have a positive image of agricultural education, and recommended that further research be conducted on these perceptions.

Like principals, guidance counselor's perceptions are also important to the growth, development, and success of middle school agricultural education programs. Georgia counselors perceptions' were studied by Woodard and Herren (1995) over 15 years ago. These researchers administered a list of statements to which the counselors responded according to their level of agreement with each statement. They concluded that, as a group, guidance counselors were positive about the benefits of agricultural education. While a guidance counselor will most likely not make decisions regarding the installation of an agricultural education program, their perception may be important to administrators who will make these decisions.

The movement to increase enrollment in agricultural education through building middle school and elementary agricultural education programs began in the late 1980's with research published by Jewell in 1989. Jewell found that increasing the number of introductory agricultural courses might be best accomplished by offering agricultural education programs in middle and elementary schools (1989). These recommendations are in line with what other researchers discovered to be barriers to building enrollment in agricultural education programs. Riesenberg and Lierman (1990) analyzed the perception of administrators and teachers in agricultural education on a list of factors that could influence enrollment. Their results concluded that scheduling conflicts, changes in students' interests and attitudes toward agriculture, competition with other elective courses, and academically oriented students being guided away from secondary agriculture were the major factors that influence enrollment. It is reasonable to conclude from Jewell's (1989) research that offering agricultural education to younger students could provide access to agricultural education to more students in spite of the competing factors.

Middle school administrators may have a positive attitude of agricultural education only if they are aware of the benefits (Kalme & Dyer, 2000). Kalme and Dyer (2000) also stated,

> If principals are interested in, knowledgeable about, have a positive image of, and are involved in agricultural education programs, they will likely support the program in both words and actions. Consequently, if beliefs are negative interest, knowledge, image and activities of support will likely also be limited (p.117).

Middle school principals that have never been exposed to agricultural education may not understand how an agricultural education program could benefit the students of their schools. Once principals realize the benefits, agricultural education can gain administrative support. Rayfield and Wilson (2008) stated,

> Examining principals' views of career and technical education programs may give some indication as to the climate in which those programs are conducted. If we can understand what affects principals' perceptions we can better address those attitudes and work toward improving the principals' views which in turn can strengthen career and technical education (p. 2).

The theoretical framework for this study draws from Gregory's Perception Theory and Wertsch's Social Constructivist Theory. Gregory (1980) argued that perception is a constructive process which relies on top-down processing, meaning an individual perceives a situation or object to be what that individual most likely thinks the object should be. When looking at a situation or object, an individual will develop an idea of what that situation or object is; upon further investigation the idea is often confirmed to be correct, thus perpetuating this process of constructivist perception (Gregory, 1980). Middle school principals perceive middle school agricultural education to be what they think it is most likely to be. The results indicate that if middle school principals have a negative perception of agriculture or FFA, they will have a negative perception of middle school agricultural education.

Constructivist theory was greatly influenced by Jean Piaget (1950) who proposed individuals construct new knowledge through acquisition and assimilation of new information through experience. Social Constructivism recognizes the individual's unique needs and backgrounds and supports the idea that individuals assimilate new information through complex interactions with those they encounter, their previous experiences, and cultural backgrounds (Wertsch, 1997).

For the purpose of this study, Social Constructivism addresses how the middle school principals have or have not learned about middle school agricultural education programs, and Gregory's Perception Theory addresses middle school principals' perceptions of middle school agricultural education. In the absence of experiences on which to construct their knowledge of agricultural education, middle school principals' create a perception of middle school agricultural education that may not always be accurate.

Similar to the way John Locke (1632-1704) viewed learning as an individual writing knowledge on the blank slate of their mind, Social Constructivism explains middle school principals' perception of agricultural education. A lack of knowledge in middle school principals regarding agricultural education can be expected if they have not been exposed to the agricultural education experience; they have no knowledge to write on the blank slate of their mind. These theories directly address and apply to middle school principals who construct their view of middle school agricultural education programs based on their experiences and perceptions of what they hypothesize agricultural education to be.

While many benefits of agricultural education have been documented (Parr, Edwards, and Leising, 2006, Young, Edwards, and Leising, 2009, Rossetti, Padill, & McCaslin, 1992, Wang & King, 2009) and agricultural education has a positive perception among many school administrators (Hinkson & Kieth, 2000; Kalme & Dyer, 2000), very little research exists that reveals middle school principals' perception of middle school agricultural education. This study was conducted in Georgia to better determine middle school principals' perceptions of their agricultural education programs. With this knowledge, university faculty and Georgia Department of Education staff can address any negative perceptions that may exist and work to improve the overall image of middle school agricultural education in hopes of increasing the number of new programs.

Purpose and Objectives

The purpose of this study was to determine how middle school principals perceive middle school agricultural education programs in the state of Georgia. The specific objective of this study was to elicit responses from individual middle school principals, that have active middle school agricultural education programs in their schools, concerning their familiarity with and perceived value of agricultural education. Further, the need to inform principals interested in starting an agricultural education program in their school about their peers' perceived benefits of middle school agricultural education makes this study important (Rayfield & Wilson, 2008).

Methods

This study was descriptive in nature utilizing survey research methodology. The target population for this study was all middle school principals in Georgia with active agricultural education programs. A list was compiled from the Georgia Agricultural Education website of all Georgia middle schools with agricultural education programs. The website revealed 74 middle schools from across the state of Georgia; this list of 74 middle schools was then confirmed by the Georgia Agricultural Education Department state staff. Once the list was secured, the researcher obtained mailing addresses of the principals of those schools, along with emails for the principals, and fax numbers for each school, from the Georgia Department of Education website. The researcher also obtained the email addresses for the agricultural education teachers at each school from the Georgia Agricultural Education website.

In order to ensure validity, the researcher utilized a panel of experts (university faculty and state Department of Education staff) to review the survey for face validity. Because an instrument that met the needs of this study did not exist, two separate instruments were combined to yield one reliable and valid instrument. The first instrument that was modified for use in this study was created by Hinkson and Kieth (2000) and measured attitudes and perceptions of high school administrators. The second instrument that was modified to develop this instrument was created by Dormody and Seevers (1994) and concentrated on leadership development through agricultural education.

Due to the age of the existing instruments that were modified to create the instrument used in this study, the same panel of experts that verified the validity of the instrument was employed to revise, update, and create a new instrument to better reflect middle school agricultural education in Georgia. In addition, a pilot study was conducted with the aid of high school principals of schools that have agricultural education programs. In order to ensure instrument reliability SPSS 16.0 was utilized to analyze the results of the pilot test and calculate the Cronbach's coefficient alpha for each construct of the instrument and the entire instrument. The alpha levels for construct I (familiarity), construct II (math and science), and construct III (leadership) were 0.97, 0.91, and 0.85 respectively. Additionally, the alpha level for the entire instrument was calculated to be .91.

Middle school principals were sent a letter of intent and electronic survey questionnaire via email. After five rounds of emails, the researcher sent hard-copy letters of intent and surveys to the agricultural education teachers of the schools whose principals had not responded. Principals were given two additional weeks to respond. Following this two week period, the researcher then faxed the letter of intent and the survey to the principals that had not responded. The culmination of these steps yielded 33 surveys resulting in a 45% response rate. In order to control for non-respondents, early and late-responders were compared and no significant difference was found between these groups (Lindner, Murphy, & Briers, 2001).

SPSS 16.0 was used to complete the statistical analysis of the data collected. For the personal data portion of the instrument, frequencies were reported. On the familiarity section of the instrument, grades and test scores, and leadership section of the instrument the mean and standard deviation were used to reflect how the principals perceived each statement.

Findings

The majority of principals, 23 out of 32 respondents, reported serving as a principal between one and eleven years, and 29 out of 32 responded that the number of years that they had been at their respective schools was between one and seven years (Table 1).

Table 1

Years of service

How long …	Less than 1 year	1-3 years	4-7 years	8-11 years	12-15 years	15 years or greater
…have you served as a principal?	2	12	9	8	0	1
…have you served as principal at the school you are currently at?	3	16	10	2	1	0
…has the current Agricultural Education teacher served at your school?	2	17	9	3	1	0

Over 60% of the principals were male and over 90% surveyed were an assistant principal before they became a principal. Over half of the principals were raised in a rural area and approximately 55% were between the age of 40 and 49. Twenty-one (64%) of the principals reported working less than six years with an agricultural education teacher and 94% reported enjoying their job as principal.

Ninety-four percent of the principals did not hold a degree in agricultural education, 79% were never in FFA, and over 75% did not have children that were involved with FFA (Table 2). Over half of the principals had participated as a member or volunteer of an agriculturally-related program excluding FFA, and nearly half had children that had participated as a member or volunteer in an agriculturally-related program excluding FFA.

Table 2

Personal data of Georgia middle school principals

	Yes	No
Do you hold a degree in Agricultural Education or a closely related field?	1	31
Were you ever a member of FFA?	6	26
Have your children ever been members of the FFA?	7	25
Have you ever participated as a member or volunteer in an agriculturally related program excluding FFA, 4-H or Georgia Young Farmers?	17	15
Have your children ever participated as a member or volunteer in an agriculturally related program excluding FFA, such as 4-H or Georgia Young Farmers?	16	16

For familiarity and the scales that follow, data were treated as interval, therefore, means and standard deviations were calculated for items on the survey.

According to the findings, principals were "familiar" with agricultural education. All but one of the statements had a mean response of 3.00 or greater indicating that the principals perceive the agricultural education program as being an important component of the local educational system (Table 3).

Table 3

Principals' familiarity with agricultural education

As a principal, I believe…	*M*	*SD*
the agricultural education program is an important part of the school.	3.65	0.47
the agricultural education program is an important part of the community.	3.62	0.54
the middle school agricultural education program provides equal opportunities for all middle school students.	3.56	0.56
I know the duties of an agricultural education teacher.	3.50	0.50
I recognize those students in the agricultural education program and FFA for their achievements, honors, and awards.	3.50	0.50
the middle school agricultural education program places enough emphasis on actual classroom teaching.	3.46	0.56
there are a number of agricultural education events, other than FFA	3.38	0.71

activities, outside of the classroom and laboratory that are co-curricular, such as field trips.		
my attendance is important at agricultural education program activities and FFA events.	3.31	0.52
I place as much interest on the agricultural education program as I do other programs.	3.28	0.58
I know the duties of a FFA advisor.	3.25	0.62
I know what a CDE (Career Development Event) is.	3.00	0.96
I know what a SAE (Supervised Agricultural Experience) is.	2.93	0.93

Note. 4=strongly agree; 3=agree; 2=disagree; and 1=strongly disagree

Principals were asked to share their perceived knowledge of how agricultural education curriculum impacts their students' performance in math and science. The principals felt that the agricultural education curriculum positively impacted students' performance on both math and science – locally and with the state mandated Criterion-Referenced Competency Test (CRCT) (Table 4).

Table 4

Principals' perceptions of agricultural education curriculum impact on students' science and math scores

As a principal, I believe that as a result of being enrolled in the agricultural education program at my school, students'…	*M*	*SD*
scores on the science portion of the CRCT are…	3.12	0.32
grades in science courses are…	3.12	0.32
scores on the math portion of the CRCT are…	3.06	0.34
grades in math courses are…	3.06	0.34

Note. 4=strongly positively impacted, 3=positively impacted, 2=negatively impacted, and 1=strongly negatively impacted.

Principals perceive their schools' agricultural education program as having a positive impact on their students' leadership skills (Table 5). Most importantly, they viewed the agricultural education program as having a positive impact on students' ability to set goals (*M*=3.56, *SD*=0.50), to have a positive self-concept (*M*=3.53, *SD*=.50), and problem solve (*M*=3.50, *SD*=.50). Following is the scale used to present the data in Table 5: 4=strongly agree; 3=agree; 2=disagree; and 1=strongly disagree.

Table 5

Principal perceptions of how agricultural education impacts student leadership at their school

As a principal, I believe that as a result of being enrolled in the agricultural education program at my school, students…	*M*	*SD*
can set goals.	3.56	0.50
have a positive self-concept.	3.53	0.50
can use information to solve problems.	3.50	0.50
can solve problems.	3.46	0.50
consider input from all group members.	3.40	0.55
respect others.	3.40	0.55
get along with others.	3.40	0.49
can delegate responsibility.	3.37	0.54
can listen effectively.	3.37	0.54
can consider alternatives.	3.37	0.54
exhibit more leadership skills than students that are not enrolled in the agricultural education program.	3.34	0.60
use rational thinking.	3.33	0.54
are open to change.	3.32	0.62

Note. 4=strongly agree, 3=agree, 2=disagree, and 1=strongly disagree.

When each construct of principal's perceptions of agricultural education is compared against each other, principals rated leadership development and general program familiarity higher than the impact of the program on academic areas such as math and science (Table 6).

Table 6
Principals' familiarity with agricultural education, agricultural educations impact on student achievement in math and science, and student leadership attributes.

Construct	*M*	*SD*
Familiarity	3.37	0.62
Math and Science	3.17	0.37
Leadership	3.40	0.54

Conclusions/Recommendations/Implications

The results from this study are limited in terms of generalizability as this study is limited to only the state of Georgia and the respondents represent 45% of the total population of middle school principals in Georgia with agricultural education programs. Readers should take caution when interpreting the results of this study.

The majority of principals, 23 out of 32 respondents, reported serving as a principal between one and eleven years, and 29 out of 32 responded that the number of years that they had been at their respective schools was between one and seven years. Twenty-one (64%) of the principals reported working less than six years with an agricultural education teacher. Ninety-four percent of the principals did not hold a degree in agricultural education, 79% were never in FFA, and over 75% did not have children that were involved with FFA. Participants had very little experience with agricultural education (degrees, FFA, SAE), yet they were seemingly "familiar" with the program. With a constructivist theory base supporting the study, it was unexpected that the participants (with very little experience in agricultural education) would agree with nearly all of the familiarity statements. Perhaps administrators were hesitant to show ignorance of the program or maybe they felt it was their duty to report only positive statements in regards to the programs of which they are responsible. Researchers recommend future principal perception studies comparing perceptions of the agricultural education program to perceptions of other formal and non-formal activities. This would provide a better measure of what principals really know, understand, and appreciate about the program.

The theory base for this study (Gregory, 1980) stated that perception is reality. Overall, and without a comparison situation as described above, the principals perceived the agricultural education program as a positive component of their local school systems. Kalme and Dyer (2000) found similar results. The principals felt that the agricultural education program provides equal opportunities for all middle school students, assists students in building a cadre of leadership attributes, and places enough emphasis on actual classroom teaching. Interestingly, principals were least familiar with some of the most important program activities. Although principals reported agreement with understanding the duties of an FFA advisor, what a CDE is, and what an SAE is, these three important activities were rated the lowest. In addition to including comparison groups, perhaps future studies should interview principals to reach an even deeper understanding of their level of understanding of the program.

This research resulted in findings that were consistent with earlier studies (Hinkson & Kieth, 2000; Kalme & Dyer, 2000) that found administrators to have generally positive perceptions concerning agricultural education. Similarly, principals agreed that agricultural education curriculum positively impacts a students' performance on both math and science, both locally and at the state level with the Criterion-Referenced Competency Test (CRCT). This finding is consistent with empirical results that have shown the benefits for students associated with contextualized instruction in mathematics through agricultural education (Parr, 2004; Parr, Edwards, and Leising, 2006; Young, Edwards, and Leising, 2009). However, the impact of math and science construct was the lowest. Furthermore, hovering around a mean of three out of a scale topping out at four hardly seems like a strong enough case for claiming that middle school principals have much respect for the impact of the agricultural education program on standardized tests. It is recommended that future studies identifying perceptions regarding the academic impact of the program employ a scale with greater opportunity for variance.

In addition to the aforementioned recommendations, replication of this perception study in Georgia and in other states should be conducted to improve the generalizability of the findings. Research should also be conducted to compare how Georgia middle school principals with and without agricultural education programs at their school perceive agricultural education.

Middle school principals also agreed that leadership development was taking place through the program. But again, comparison groups and interviews should be employed to determine a more accurate appraisal from administrators.

In terms of action steps to follow, an effort should be made to educate Georgia middle school principals with agricultural education programs at their school on the duties of a FFA advisor and the integral parts of agricultural education. An effort should also be made to further educate Georgia middle school principals with agricultural education programs at their school about the benefits of agricultural education.

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An Analysis of North Carolina Public School Superintendents' Awareness of Biotechnology and the Future of Biotechnology Education

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An Analysis of North Carolina Public School Superintendents' Awareness of Biotechnology and the Future of Biotechnology Education

Abstract

The purpose of this study was to gauge the perception of North Carolina public school superintendents regarding Biotechnology and its future in the North Carolina public school curriculum. It was found that respondents overall were knowledgeable about biotechnology and saw it as beneficial in general health, nutrition, and environmental quality. With regard to the barriers of biotechnology respondents indicated that religious concerns, lack of education, ethical issues, access, labeling, and legislation were barriers. In contrast, respondents were undecided if socioeconomic factors, ecological factors, and perceptions regarding the safety of genetically engineered organisms were barriers. As for the future of biotechnology education respondents indicated that universities and industry would be important to its future, but were undecided if public support existed with respect to its implementation. Also uncertainty surrounded the need for more rigorous teacher preparation programs and the need for special programs with respect to workforce preparation. Recommendations included biotechnology stakeholders forming partnerships with school administrators and key community leaders in order to ensure the future of biotechnology education in North Carolina.

Introduction

The rapid pace of technological innovation coupled with great economic uncertainty has significantly impacted the way business is conducted within the 21st century global society. With this change comes the need for companies, particularly those within the bioscience sectors, to fill entry-level and advanced positions with individuals who possess cutting edge knowledge, dynamic skills, and excellent dispositions to successfully maneuver in a highly competitive and high-stakes industry. Given the aforementioned factors, biotechnology firms many times are in need of more highly skilled workers than are available, particularly in training programs within their local region (United States Department of Labor, 2008).

According to the Battelle Technology Partnership Practice (2009), there are many indicators that show the United States is slipping in generating the skilled educated workforce that is necessary to meet the requirements for a highly technical and trained workforce in the knowledge-based economy of today. Workers are needed in the bioscience industry to translate innovation into product development, conduct research, improve health care techniques, and produce bioscience related products. The availability of a highly skilled and educated workforce is imperative to the United States sustaining a highly competitive and vigorous bioscience industry for the long run. This is especially important from an economic security perspective as other nations are gaining ground in the Science, Technology, Engineering, and Math (STEM) disciplines, while interest among American students in the STEM areas continues to decline.

The Food and Agriculture Organization of the United Nations (2010) defined biotechnology "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." Given that biotechnology is not just comprised of one discipline, but the blending of many disciplines, the ideal training for employees in biotechnology is traditional biological science, with specific emphasis upon areas such biochemistry, molecular biology, virology, genetics, and biochemical engineering. Taking into account the aforesaid factors and the ever changing biosciences industry, firms are consistently seeking workers with more formalized training in both life sciences and computers, coupled with a strong general educational background (United States Department of Labor, 2008).

With regard to the bioscience industry, over 1.42 million individuals were employed in 2008. In the area of research, testing, and medical labs, 11,670 jobs (2.1 %) were added from 2007 to 2008, medical devices and equipment added 10,140 jobs (2.4 %), and agricultural feedstock and chemicals added 5,021 (4.6 %). According to Battelle Memorial Institute (2010), the total employment by sector was as follows: Agricultural Feedstock & Chemicals (114,793), Drugs & Pharmaceuticals (311,882), Medical Devices & Equipment (435,509), and Research, Testing, and Medical Laboratories (558,140).

In order to ensure America' s continued economic growth and national security advances in science and engineering, particularly in biotechnology are essential. Over the next decade, the demand in the United States for scientists and engineers is projected to increase at four times the rate of all other occupational sectors. Despite this factor, high school students of today are not performing at sufficient levels in math and science, with even fewer pursing degrees in various technical fields (The International Society for Optical Engineering, 2008a). When analyzing this concern with respect to demographics only 4.4 % of science and engineering jobs are held by African Americans and only 3.4 % by Hispanics. With regard to gender, significant gaps exist in this area as well according to numerous studies (The International Society for Optical Engineering, 2008b).

The International Society for Optical Engineering (2008b) stated interest in STEM education has greatly declined with the majority of students in the United States not adequately prepared to succeed in college-level coursework. Moreover, students who were the most likely to pursue studies in STEM career pathways are those who develop a disposition for these respective areas early in career planning and enroll in challenging courses that provided them with the preparation for college-level science and math coursework. Public funding and support are not only critical to alleviating the aforementioned issue, but also assist in economic growth. According to many economists over the past 50 years, taxpayer investment in science and mathematics in essence has indirectly produced more than half of the nation's economic growth, an economic investment that starts within the public educational systems (The International Society for Optical Engineering, 2008b).

According to the North Carolina Department of Public Education (2006), North Carolina has the third largest concentration of biotechnology companies in the United States. The biotechnology industry in North Carolina is comprised of 110 contract research and testing companies, 60 agricultural biotechnology companies, 13 publically traded companies that have a market capitalization of $11.8 billion, and employ over 57,000 individuals. Of these companies at least 75 are based upon North Carolina's universities technologies. In North Carolina about 145 bioscience patents are granted each year to companies and universities, which accounts for about 12% of all patents issued in the state. Biotechnology has an annual impact upon North Carolina's agricultural industry. In 2006, the food and fiber production was increased by 86.6

million pounds and pesticide use was reduced by 3.5 million pounds (North Carolina Biotechnology Center, 2010b).

The future viability of North Carolina’s biotechnology industry greatly depends upon the development of essential knowledge, skills, and dispositions in regard to biotechnology in the public school students of today, who are the industry’s future workers and consumers (United States Department of Labor, 2008). According to the North Carolina Biotechnology Center (2010a) in the state of North Carolina biotechnology is not offered as a core science option in the standard course of study, but instead is embedded across various courses within the Career and Technical Edcuation areas of Agricultural Education (Biotechnology and Agriscience Research I&II, Horticulture I&II), Family and Consumer Science (Foods II – Food Technology), Technology Education (Scientific and Technical Visualization I&II, Project Lead The Way – *Biotechnical Engineering specialty course*), and Health Occupations (Biomedical Technology, Medical Sciences I&II).

The State of North Carolina has made a commitment to biotechnology with its BioNetwork Initiative program. The program is located within agricultural education programs at community colleges and universities that are industry focused, providing hands-on training for an industry that greatly values the technical and scientific training of its employees. The BioNetwork established its center for BioAgriculture at Robeson Community College. The commitment also includes the North Carolina Department of Public Instruction and local education agencies (LEAs) throughout the state of North Carolina. The commitment to educational initiatives such as biotechnology by local education agencies is heavily influenced by superintendents, who are vital to the successful incorporation of any subject matter into the curriculum. Without their support, initiatives such as biotechnology are not feasible (North Carolina Biotechnology Center, 2009). Given the importance of the biotechnology industry to North Carolina’s economic vitality, it is imperative that North Carolina’s public schools chief administrators support the incorporation of biotechnology throughout the standard course of study on a broader scale.

Theoretical Framework

The theoretical framework for this study was built upon the theory of social judgment and the concept of cognitive dissonance. The theory of social judgment focuses on how people's prior attitudes distort their perceptions of the positions advocated in persuasive messages and how such perceptions mediate persuasion. Specifically, the theory assumes that a person's own attitudes serve as a judgmental standard and anchor that influences where along a continuum a persuader's advocated position is perceived to lie (Sherif & Hovland, 1961). The social judgment theory is an attempt to apply the principles of judgment to the study of attitude change (Sheirf & Hovland, 1961). According to Sherif, Sherif, and Nebergall (1965), an individual's initial attitude serves as an anchor for the judgment of related attitude communications. Opinions are evaluated against this point of reference and are placed on an attitudinal continuum. Opinions that most characterized the individual's own opinion are in the latitude of acceptance. Those opinions found most objectionable are placed in the latitude of rejection. The latitude of non-commitment consists of those opinions that are neither accepted nor rejected.

Communication that falls within the latitude of acceptance is assimilated and if judged to be fair and unbiased will result in a change in attitude within the limits of the latitude of acceptance. The greater the difference between the initial opinion and the communicated opinion, the greater the attitude change. Though some change is possible when opinions fall within the latitude of rejection, the greater the discrepancy the less the change in attitude (Himmelfarb & Eagly, 1974). In summary, social judgment theory is important because it demonstrates the importance of people's prior attitudes. Most other learning theories only deal marginally with previous attitudes. Newer theories incorporate social judgment principles as covariates and control variables in experimental designs (Wood, 1982).

In addition to the theory of social judgment, the concept of cognitive dissonance served as guiding framework for this study. According to Swanson (1972) a person will gradually begin to associate positive communications to an area or a subject, in this case biotechnology, as their knowledge increases, which in turn affects their attitude, and finally behavior towards biotechnology. The concept simply stated is that knowledge and experiences are precursors to attitudinal changes that must occur before behavior can change (See *Figure 1*.)

Education → Knowledge→ Attitudes→ Behavior

Figure 1. Assumed relationships among education, knowledge, attitude, and behavior – Concept of Cognitive Dissonance (Swanson, 1972).

Purpose and Objectives

The purpose of this study was to gauge the perception of North Carolina public school superintendents regarding Biotechnology and its future in the North Carolina public school curriculum. In order to accomplish the aforementioned purpose, the following research questions were developed.

1. What was the awareness level held by North Carolina Public Superintendents regarding biotechnology?
2. What was the confidence level held by North Carolina Public Superintendents regarding their awareness of selected biotechnology factors?
3. What were the benefits of biotechnology as perceived by North Carolina Public School Superintendents?
4. What were the barriers to biotechnology implementation as perceived by North Carolina Public School Superintendents?
5. What was the future of biotechnology education in North Carolina Public Schools as perceived by North Carolina Public School Superintendents?
6. What were the demographic characteristics of North Carolina Public School Superintendents who Local Education Agency possessed at least one agricultural education program?

Methodology

The population for this descriptive study consisted of North Carolina Public School Superintendents whose respective local education agency (LEA) possessed at least one secondary agricultural education program. Of the 115 local education agencies in North Carolina, 93 possessed at least one agricultural education program. Given this factor the final study population was determined to be 93. In order to accomplish the aforementioned objectives of this study a survey instrument was adopted from a previous study conducted by Totten (2007). The survey instrument consisted of five sections. The sections were entitled Section I: General Awareness of Biotechnology, Section II: Benefits of Biotechnology, Section III: Barriers to Biotechnology, Section IV: Future of Biotechnology Education in North Carolina, and Section V: Demographic Characteristics. The validity of the instrument was established by means of content validity. Brown (1983) defined content validity as "the degree to which items on a test representatively sample the underlying content domain (p. 487)." Brown recommended using expert judges as one means of establishing content validity. A panel of experts at the researchers' respective university reviewed the survey instrument for content validity, no adjustments were made as a result of the review. To establish internal consistency reliability, the instrument was analyzed using the software package SPSS according to conventions established by Nunnally (1967) and Davis (1971). The Chronbach's Alpha Coefficients for the study were as follows: Section I: .9273, Section II: .9782, Section III: .9096, and Section IV: .9500. All sections of the research survey were deemed to be reliable.

Elements of Dillman's Tailored Design Method (2009) were utilized to achieve an optimal return rate. A three-round web based questionnaire approach was utilized for this study. The first round consisted of all superintendents within the selected population receiving a letter from the researchers outlining the purpose of the research, which included a login and password for each prospective respondent. Superintendents were given one week to return the initial survey, 24 surveys were returned after the first week. The next round consisted of all non-respondents receiving a follow-up email stressing to them the importance of returning the survey for data analysis purposes and to strengthen the study, this resulting in ten more surveys. A final reminder email was sent at the end of the beginning of the third week, this resulted in nine more surveys being returned. After all collection rounds were completed the final total was 43 returned for a response rate of 46 %. In order to control for non-response error, Miller and Smith (1983) recommended comparing early to late respondents. Upon completion of the study, an evaluation of the data showed that there were no significant differences found among the early respondents (respondents during the first round) and the late respondents (respondents after the first round).

Findings

Research Question One Findings

In relation to superintendents' knowledge of biotechnology it was found that participants overall were aware of the selected biotechnology concepts addressed in the survey, with the exception of four statements. For the purposes of this research a statement was operationalized to possess a level of awareness if more than 50% of respondents answered the statement correctly. As shown in Table 1, exceptions were found with regard to perceptions of the development of human organs within livestock species, governmental required labeling of genetically modified products, biotechnology regulation based upon use versus method of production, and lastly traditional livestock and crop production utilizing cross-breeding and cross-fertilization.

As far as confidence with regard to their responses, participants in general were sure of their answers, with exceptions being found on seven statements. For the purposes of this research a statement was operationalized to be answered affirmatively if more than 50% of respondents indicated they were sure about their response to the biotechnology statement. Exceptions were noted in relation to perceptions regarding the percentage of meat products that are from genetically-modified livestock, biotechnology being utilized to create new living organisms, cloning, the strength of genetically modified animals, labeling of genetically modified products, biotechnology regulation based upon utilization, and traditional livestock and crop production utilizing cross-breeding and cross-fertilization.

Table 1

General Awareness of Biotechnology

Statements	*f* True	*f* False	*f* Sure	*f* Unsure
Biotechnology is defined as the use of molecules from living organisms to create new products.	33*	10	26	18
Biotechnology makes it possible for scientists to create new plants and animals by taking parts of the genes of one plant or animal and inserting them into another.	32*	11	20	24
Human, animal, plant and microbial genes can be altered with current biotechnology techniques	38*	5	28	15
Genes control visible and invisible characteristics of living organisms.	41*	2	34	10
A gene is a specific sequence of DNA that serves as a unit of inheritance.	41*	2	34	10
Most consumers in the United States have eaten food products created through biotechnology.	41*	2	34	10
A large percentage of meat products bought by consumers are obtained from genetically-modified livestock.	41	2*	33	11
Forensic biotechnology allows the analysis of DNA to help solve crimes.	23*	21	22	21
Pharmaceutical companies currently market drugs developed using biotechnology.	41*	2	34	10
Plant biotechnology can regenerate whole plants from individual plant cells.	40*	3	32	12
Cloning of a plant or animal creates an identical copy.	37*	6	19	24
Biotechnology has allowed the development of livestock that produce human organs that will	33	9*	26	16

not be rejected by transplant recipients.				
Genetically-modified animals are larger and stronger than normal.	15	26*	15	27
The government requires that all genetically-modified products have clear labeling.	14*	29	13	28
The Environmental Protection Agency regulates all biotechnology products.	22*	21	23	20
Biotechnology products are regulated based on their use rather than on the method by which they were produced.	15*	28	16	26
Genetically-modified bacteria, fungi, and plants can clean up toxic waste sites in a process called bioremediation.	26*	13	10	32
Pesticide-producing genes can be directly incorporated into crop plants so the need for additional pesticide application is reduced or eliminated.	36*	5	14	29
Traditional livestock and crop production does not use cross-breeding or cross-fertilization.	34	9*	23	21

*****Correct Response

Research Question Two Findings

Respondents were asked to give their opinion on the benefits of biotechnology. Table 2 presents the means and standard deviations (SD) for the benefits of biotechnology. For the purpose of data analysis, readers should utilize the following specifications when interpreting the scale for Tables 2, 3, and 4 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49=Uncertain, 3.50-4.49=Agree, and 4.50-5=Strongly Agree. In relation to the perceived benefits of biotechnology respondents agreed with all 20 statements. The highest levels of agreement was noted in relation to the perception of the development of unique products from aquatic sources, increased crop yields on less land, more accurate criminal investigations, economic savings for consumers, and improved methods to fight bioterrorism. The lowest levels of agreement were found in relation to more effective waste treatment techniques, valuable technology for the United States, and reduced environmental impact from industrial activities.

Table 2

Benefits of Biotechnology

Benefits	M	SD
Development of unique products from aquatic sources.	4.39	.655
Increased crop yields that can be realized on less land.	4.35	.613
More accurate criminal investigations.	4.35	.650
Economic savings for consumers.	4.33	.644
Improved methods to fight bioterrorism.	4.30	.734

More effective pharmaceuticals.	4.26	.658
Protection of groundwater supplies.	4.19	.588
Reduced need for chemical pesticides.	4.14	.675
Alleviation of malnutrition.	4.14	.833
Better animal health management.	4.09	.750
Improved fabrics.	4.02	.762
Improved human medical care.	3.95	.844
More nutritious and better tasting foods.	3.95	.899
New fuel sources.	3.91	.684
Improved soil conservation.	3.88	.905
Increased quality of life for people in developing countries.	3.88	.731
Greater economic profitability for farmers.	3.86	.824
Reduced environmental impact of industrial activities.	3.84	.814
Valuable technology for the citizens of the United States.	3.84	.843
More effective waste treatment techniques.	3.65	1.11

Research Question Three Findings

Respondents were asked to give their opinion on the subject of barriers and obstacles in relation to biotechnology. Table 3 presents the means, standard deviations (SD), and rank for the barriers and obstacles of biotechnology. The highest levels of agreements were found in relation to religion being a barrier to biotechnology, lack of education, and ethical issues regarding its use on a global scale. In contrast respondents were undecided regarding the socioeconomic perspective of biotechnology, biotechnology having a negative ecological impact, and the negative perception regarding the safety of genetically engineered foods.

Table 3

Barriers to Biotechnology

Barriers and Obstacles	M	SD
Religious concerns are a major barrier to biotechnology acceptance.	4.48	.590
Lack of education leads to resistance toward biotechnology products.	3.98	.628
Ethical issues regarding biotechnology are a major barrier to its extensive use on a global scale.	3.95	.776
Equal access to the benefits of biotechnology will not be realized by all sectors of society.	3.82	.947
Issues concerning the labeling of genetically modified foods can have a major impact upon the agricultural industry.	3.73	.924
Legislation is a major barrier to broad biotechnology implementation throughout society.	3.59	.787
The economic cost of biotechnology research is a barrier to its widespread practical daily implementation.	3.50	.792

From a socio-economic perspective biotechnology can affect the relationship between and relative power of different groups in society.	3.45	1.044
Biotechnology can have negative ecological impacts which reduce its acceptance.	3.34	.888
The negative perception regarding the safety of genetically engineered food is a major barrier to biotechnology.	3.18	.870

Research Question Four Findings

Respondents were asked to give their opinion on the subject of the perceived future of biotechnology education. Table 4 presents the means, standard deviations (SD), and rank for the future of biotechnology education. The highest level of agreements were found in relation to offering biotechnology as a general science core option, utilizing industry and university biotechnology specialist to teach special topics within the public schools, and infusing industry grants into public schools in order to encourage biotechnology incorporation. In contrast respondents were undecided if special programs concerning biotechnology should be implemented for students with an interest in the industry. Additionally, indecision was noted with regard to whether teacher education programs should revise their respective baccalaureate degree programs with respect to biotechnology and whether there would be great public support for biotechnology education at the secondary level.

Table 4

Future of Biotechnology Education

Statements	M	SD
Biotechnology should be offered as a general science option for the core curriculum.	4.34	.645
Industry and university biotechnology specialists should be utilized to teach special biotechnology topics in the public school systems.	4.26	.621
Industry grants should be provided to public school systems to infuse biotechnology education into their respective curricula.	4.25	.811
North Carolina students will be interested in enrolling in biotechnology courses and programs.	4.05	.806
Industry leaders should aid in biotechnology curriculum development in North Carolina’s public schools.	4.05	1.05
Special programs concerning biotechnology should be implemented for “college/university” prep students.	4.02	.731
Internships should be provided in biotechnology-related organizations as an option for “College Tech Prep” work-based experience requirements.	4.00	1.01
North Carolina’s universities should have a major impact on the infusion of biotechnology at the secondary level of education.	4.00	.610
Universities should offer advanced placement courses concerning biotechnology at the secondary level.	3.91	.830

Public school administration overall should be supportive of biotechnology education.	3.84	1.03
Biotechnology education can help alleviate negative public perception regarding the industry.	3.82	.843
The supply of qualified teachers to teach biotechnology will be very low.	3.75	.967
Programs should be developed to link secondary level education in biotechnology with current community college biotechnology programs.	3.68	1.07
Industry and university biotechnology specialists should be utilized to teach special biotechnology topics in the public school systems.	3.66	.834
The North Carolina General Assembly should provide funding to develop and infuse biotechnology curriculum into the public school system.	3.59	.923
Special programs concerning biotechnology should be implemented for students hoping to enter the bio-manufacturing workforce after high school graduation.	3.41	1.14
The infusion of biotechnology into North Carolina's standard course of study will require teacher education programs to revise and plan more rigorous baccalaureate degree programs.	3.30	.823
There will be great public support for biotechnology education at the secondary level in North Carolina.	3.20	.878

Research Question Five Findings

Table 5 displays the demographic characteristics of the North Carolina public school superintendents who participated in this respective study. The average age of respondents was 53 years of age, with the majority being Caucasian males who held a doctorate degree. In relation to years of public education experience, the average experience level was 22 years, with seven being the average years of experience as a superintendent.

Table 5

Demographic Characteristics of North Carolina Public School Superintendents

Demographics	n	M or %	SD
Age		53	5.34
Gender			
Male	35	80	
Female	9	21	
Race			
Caucasian	37	84	
Black	7	16	
Years of Public Education Experience		20	**7**.04
Administrative Experience as Superintendent		7	5.30

Education		
Masters	8	18
Specialist	10	23
Doctorate	26	59

Table 6 provides the demographic data for the local education agencies (LEAs) for which the respondents administrate. With regard to the average number of schools within the LEAs, 20 were found to be the mean level, with an average enrollment level of 12,945 students. The majority of the school districts were labeled as rural with 29% indicated a combination status.

Table 6

Local Education Agency Demographics (LEA)

Demographics	n	M or %
Total number of schools in L.E.A.		20
Total number of students in L.E.A.		12,945
Type of L.E.A.		
Urban	2	5
Rural	29	66
Combination	13	30

Conclusions

In relation to the knowledge level possessed by North Carolina's public school superintendents in relation to biotechnology, overall respondents were knowledgeable regarding the selected concepts and possessed a level of confidence in their respective answers. According to Swan (1972), the knowledge that a person possesses regarding a particular topic in turn influences their attitude and behavior regarding that subject matter. When considering perceptions about the benefits of biotechnology, respondents in general agreed with all statements provided. As stated by Sherif and Hovland (1961), an individual's initial attitude towards a subject serves as an anchor with regard to any future communication regarding the subject. Given that the superintendents within this study were positive about the benefits of biotechnology, the effort to infuse biotechnology broadly throughout the public schools could perhaps be easier, if the support of the superintendents is solicited for specific initiatives.

With regard to the barriers of biotechnology, respondents indicated that religious concerns, lack of education, ethical issues, access, labeling, and legislation were barriers. In contrast respondents were undecided if socioeconomic factors, ecological factors, and perceptions regarding the safety of genetically engineered were barriers. According to Eagly and Chaiken (1993), positions falling within the latitude of rejection will be contrasted away from a person's initial attitude regarding a particular subject, thus causing them to develop a negative perception regarding the specific variable.

With respect to views regarding the future of biotechnology education in North Carolina respondents agreed that industry and university experts should be involved with the development of biotechnology in the public schools, and that public school administration and the General

Assembly should support biotechnology education. It was also agreed upon that students would be interested in biotechnology programs if created and that special programs should be implemented for college prep and tech prep students in relation to biotechnology. In contrast respondents were undecided if special programs regarding biotechnology should be developed for individuals desiring to enter the bio-manufacturing industry after high school. Additionally, superintendents were undecided if the future of biotechnology education would require the development of more rigorous teacher education programs or if there would be adequate public support for biotechnology education. It appears that superintendents are supportive of biotechnology education, and recognize the need for multiple stakeholder involvement in its development, but appear to be somewhat undecided about its future in some key areas. This could be due to the variety of information that they are given about the subject that fall within their latitude of rejection, thus contrasting with their initial anchor position (Eagly & Chaiken, 1993).

Recommendations

When considering the recognized economic importance of biotechnology to North Carolina and the push for better preparation of students in relation to the STEM disciplines, it is recommended that North Carolina's public school superintendents collaborate with various stakeholder groups to ensure infusion of biotechnology throughout the North Carolina Standard Course of Study. This would aid in implementing the recent recommendations that States should incorporate biotechnology as they revise their science standards and should involve research scientists with expertise in the biosciences in their development (Battelle, 2009). As a result of President Obama's "Education to Innovate" campaign, initiatives such as the Biotechnology Institute's "Scientist in the Classroom" which is designed to train and deploy scientists from 40 companies with secondary teachers and students in high-impact laboratory, collaborations will better prepare students in the STEM disciplines (Biotechnology Institute, 2010). Collaboration such as these is the future of biotechnology education.

Implications

According to the Labor Day Report (2005) America's ability to compete in the 21st century will not be determined by just performance, but its workforce ability to invent and innovate. Regrettably, signs show that America's workforce is not prepared to meet innovation's challenge, and its position as the global economic leader is threatened. According to Paul A. Hanle (2010):

> The United States is the global leader in biotechnology innovation. Our industry creates high-wage jobs while developing breakthrough technologies that help heal the sick, feed the hungry, and restore the environment … The ability of the United States to continue to lead in the global biotechnology marketplace depends on developing new talent.

Superintendents and school administrators will be at the fore front of collaborative opportunities with the biotechnology industry as the biotechnology industry is investing in bioscience education by contributing to class room instruction through innovative programs to address needs in STEM education.

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