FACTORS RELATED TO THE INTENT OF AGRICULTURAL EDUCATORS TO ADOPT INTEGRATED AGRICULTURAL BIOTECHNOLOGY CURRICULUM

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Abstract

Recent legislation encourages the integration of academic content in agricultural education. In North Carolina, high school agricultural education programs can now choose to offer a state adopted integrated biotechnology curriculum. Empirical evidence was needed to identify and describe factors related to the intent of agricultural educators to adopt this curriculum in order to assist teachers during this transition.

North Carolina agricultural educators were randomly surveyed to determine their self-perceived level of knowledge, actual level of knowledge and perceived importance of integrated science competencies in the new North Carolina "Biotechnology and Agriscience Research" course. This descriptive and correlational study also described how agricultural educators perceived the course in fulfilling program needs, perceived barriers to teaching the course, and the likelihood of agricultural educators in North Carolina adopting the course. Exploratory research was conducted to identify factors that best predicted the intent of agricultural educators to adopt the course.

Agricultural educators accurately perceive that they lack the knowledge to teach the Biotechnology and Agriscience Research course. The majority of North Carolina agricultural educators have not participated in training related to biotechnology. Therefore they are ill prepared to teach concepts related to this emerging technology. Agricultural educators support the importance of teaching biotechnology and recognize the benefits of integrated curriculum in agricultural education. Agricultural educators perceive that the exterior factors of funding, equipment and teacher knowledge are the largest barriers to adopting integrated science curriculum. The Biotechnology and Agriscience Research course has the necessary support of agricultural educators to propose its continued inclusion in the North Carolina Workforce Development program of studies. Teachers who are most likely to adopt the Biotechnology and Agriscience Research course have fewer years of teaching experience, have attended some biotechnology training and perceive integrated biotechnology curriculum will fulfill their agricultural education program needs.

Introduction

In recent years, curriculum integration of science and agriculture has accelerated due to the biological revolution that requires the agriculturist to understand more science. Martin, Rajasekaran & Vold (1989) reported that students of agriculture must learn the biosciences, as they are the foundation of the industry of agriculture. The integration of agriculture and science curriculum has also been inspired by educational reform legislation. Since the mid-1930s the United States Department of Education has endorsed the integration of vocational and academic studies (Moss, 1990). Horne and Key (1993) reported that biotechnology is one subject area that readily integrates science and agriculture.

In 1999, North Carolina education and industry experts developed a course titled “Biotechnology and Agriscience Research” based on the standards identified in “The National Voluntary Occupational Skill Standards for an Agricultural Biotechnology Technician”. The Biotechnology and Agriscience Research course reflects the theory of the reinforcement model of integration by infusing academic content into vocational education curriculum. The National Agricultural Education Council sponsored the development of an accompanying curriculum guide titled “Biotechnology for Plants, Animals, and the Environment” that is now available to secondary agricultural education programs nationwide.

Beginning in 2000-2001, North Carolina high schools will be able to offer a state adopted integrated agricultural biotechnology course that has been developed as a cooperative effort between industry and education. It is not known whether teachers in the state will adopt this innovative course as a part of their local course offerings. North Carolina agricultural educational consultants need empirical evidence to identify factors related to the intent of agricultural educators to adopt this curriculum in order to assist teachers in the future transition of curriculum adoption. Rudd and Hillison (1995) reported that data related to the adoption of agriscience curriculum could provide insight for agricultural education curriculum efforts in the future.

Theoretical Framework

The theoretical framework for this study was derived from a review of the existing literature regarding motivation theory. The intent of teachers to adopt integrated curriculum is directly related to this area of psychological theory. Finch, Schmidt and Faulkner (1992) emphasized the importance of motivational theory to the educational movement of curriculum integration when they stated, “teachers must ultimately have the need and desire to integrate vocational and academic education. You can lead teachers to school, but you cannot make them integrate” (p.11).

Edwin Locke’s schema of motivation in Figure 1 was chosen as the theoretical framework for this study because it encompasses a combination of the most well-known and accepted motivation theories and puts them in a logical sequence. In this sequence, Locke (1991) hypothesizes that the motivation theories support one another and the weaknesses they possess when alone are diminished.

Locke (1991) stated, “the field of work motivation has become increasingly confused over the past decades. The major cause of confusion has been a plethora of theories and paucity of frameworks for integrating them. A major but seldom-recognized reason for the difficulty is that most of the theories pertain to different aspects of the motivational sequence”(p.288).

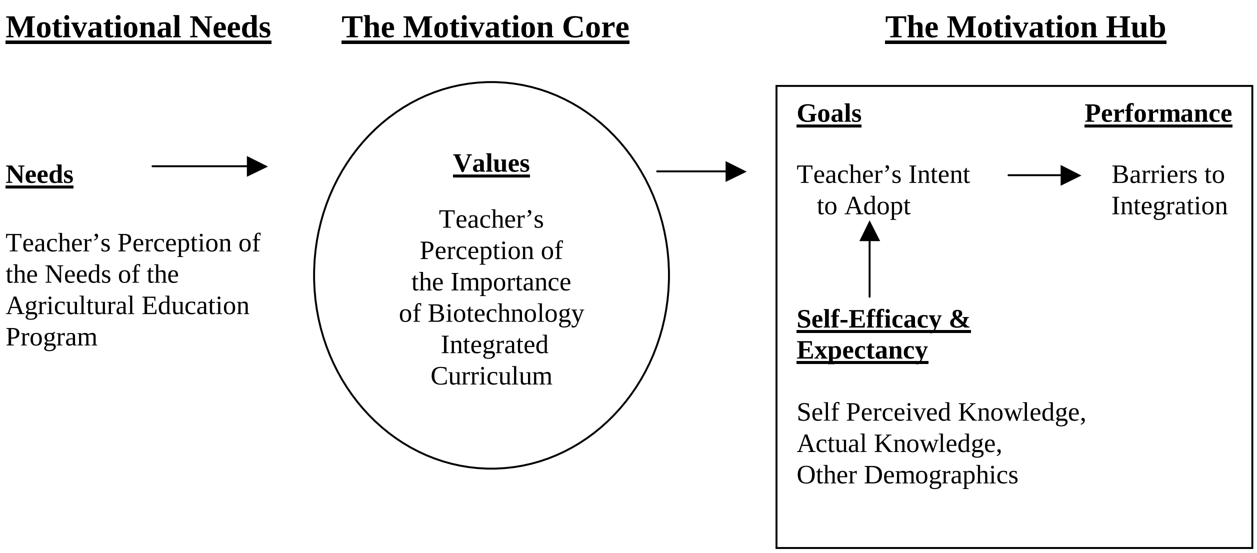

Figure 1. Application of Locke's Motivation Sequence to the Intent of Agricultural Educators to Adopt Integrated Biotechnology Curriculum.

Studies exist that suggest that agricultural educators perceive a need for integrated biotechnology curriculum. Brown, Kemp and Hall (1998) reported that 69% of the science, technology education and agricultural education teachers in Kentucky supported a need for teaching integrated biotechnology curriculum in their schools. Agricultural educators who had participated in the National FFA Agriscience Teacher of the Year at the state and national level perceived a need for the integration of science into agricultural education according to Thompson (1998). They believed that by integrating science into agricultural courses, students had a better understanding of science concepts and their application in agriculture.

Several studies have found an agricultural educator's perceived value of a curriculum is a meaningful predictor of the adoption of curriculum. Rudd and Hillison (1995) found that a teacher's expectations of an agriscience curriculum was a moderate predictor of the amount of agriscience curriculum that was adopted in agricultural middle school programs in Virginia. Although some studies conclude that the integration of science is valued, not all research concludes that this is the case. Bottoms, Presson & Johnson (1992) found that only one in ten vocational teachers believed it is important to teach science concepts in an applied manner and only two in ten reported that they could do it well.

Newman and Johnson (1994) found that, in Mississippi, teachers perceived the importance of biotechnology in their Agriscience I course to be very important, but they also felt they possessed the lowest competence in this area. Rudd and Hillison (1995) researched the adoption of a new middle grade agriscience curriculum in Virginia. They found that that the self-perceived knowledge of agriscience middle grade agricultural teachers in Virginia was the best predictor of 13 variables to predict the amount of the agriscience curriculum that was adopted and taught. Thompson and Balschweid (1999) found that 84% of the agricultural educators in a study of Oregon Agricultural Science and Technology teachers had attended at least one integration workshop and 72% of these respondents indicated that they strongly agreed or agreed that they felt prepared to teach integrated biological concepts. This high rate of self-perceived ability might be related to the fact that all the agricultural educators had received some training.

Roberson, Flowers, and Moore (1997) concluded that a lack of teacher support for educational reform in North Carolina might be due to the many barriers teachers perceive in integrating vocational and academic curriculum. These perceived barriers are important to integration efforts as Pritz and Davis (1990) reported the reluctance of teachers to change as a result of these perceptions as suggested by expectancy theory. Thompson and Balschweid (1999) found that Oregon agricultural educators surveyed felt that lack of equipment, training and funding were significant barriers to integrating science in agricultural education. Many other studies (Roberson, Flowers & Moore, 1998; Thompson & Schumacher, 1997; Newman & Johnson, 1994) have also found that teachers perceive a lack of agriscience training as a barrier to integrating agriscience in agricultural education.

Purpose of the Study

The purpose of the study was to identify and describe factors related to North Carolina high school agricultural teachers' intent to adopt integrated agricultural biotechnology curriculum. More specifically, the study intended to answer the following research questions:

1. What is the self-perceived level of knowledge possessed by agricultural educators of integrated science competencies in "Biotechnology and Agriscience Research"?
2. What is the actual level of knowledge possessed by agricultural educators of integrated science competencies in "Biotechnology and Agriscience Research"?
3. How do North Carolina agricultural educators perceive the importance of "Biotechnology and Agriscience Research" competencies in agricultural education?
4. Which agricultural education program needs do agricultural educators perceive "Biotechnology and Agriscience Research" will fulfill?
5. What is the intent of agricultural educators to adopt the "Biotechnology and Agriscience Research" course within the next six years?
6. What barriers do agricultural educators perceive to exist in teaching the "Biotechnology and Agriscience Research" course?
7. If barriers were not present, what is the best predictive model for the dependent variable of the intent of agricultural educators to adopt the "Biotechnology and Agriscience" course as related to the following independent variables; agricultural educators actual level of knowledge of the integrated biotechnology competencies, self-perceived level of knowledge of the integrated biotechnology competencies, perceived importance of the integrated biotechnology competencies, perceived fulfillment of program needs and the demographic factors of age, gender, number of years of teaching experience and number of completed

formal biotechnology courses or workshops?

Research Procedures Used

This was a descriptive/correlational study using responses from randomly selected agricultural teachers in North Carolina during the spring of 2000. A sample size of 173 from 313 teachers was determined using Cochran's formula for estimating sample size to determine the sample of a finite population (Cochran, 1977).

The instruments were reviewed by a panel of experts for content validity and pilot tested by 17 teachers who were not in the pool of randomly selected teachers. The reliability of the actual knowledge instrument was measured using the Kuder-Richardson 20 coefficient of internal consistency (Gall, Borg, and Gall, 1996). A Kuder-Richardson 20 coefficient of .81 was derived from the 35 test items. All of the multiple choice knowledge test items were considered reliable and were retained in the instrument. The stability of the questions related to teachers' perceptions were measured using the Product-Moment Correlation Coefficient (Pearson r). The initial pilot responses and the responses received two weeks later resulted in a coefficient of stability of r = 83. The perception questions were considered stable and were not revised.

The randomly selected teachers were sent a cover letter, survey, scantron form and pencil by mail along with a self-addressed stamped return envelope on May 26, 2000. They were asked to return a completed scantron form and demographic response form in the return envelope by June 16, 2000.

The total response rate was 73% ($\underline{n}$=126). According to Gay (1980) a response rate of 70% or higher reduces the risk of non-response error. Early and late respondents were compared as the basis for controlling non-response error. According to Miller and Smith (1983), late respondents are similar to non-responders. Those responses returned by June 16, 2000 were considered early respondents. Between June 16 and June 28, 2000 non-respondents were contacted by a mailed post card or phone call to encourage their participation. Responses returned between June 16 and July 5 were considered late respondents. A comparison of mean differences of the knowledge test between the two response groups resulted in $\underline{t}$=1.55, df=1.24, p=. 124 (no significant difference). Thus, the late respondents were included in the total response pool and the resultant responding sample was assumed to be representative of the target population.

The statistical analyses used to interpret the data included descriptive statistics and correlational statistics. Descriptive statistics were used to determine the mean and measure of variance (standard deviation) of the perceived knowledge of agricultural educators of integrated science competencies in the Biotechnology and Agriscience Research course, their actual knowledge of integrated science objectives in the Biotechnology and Agriscience Research course, the needs they perceived that the Biotechnology and Agriscience Research course would fulfill, their perceived value of integrated science competencies in the Biotechnology and Agriscience Research course, and the barriers they perceive exist in teaching the Biotechnology and Agriscience Research course.

Multiple regression analysis was used to determine the best model for explaining the variance associated with the intent to adopt the Biotechnology and Agriscience Research course by a linear combination of the independent variables. Stepwise elimination was used to determine the multiple regression model that best explained the dependent variable of the intent to adopt.

Findings

Demographics of participants measured by the study were teaching experience, age, gender and previous training. The mean total years of teaching experience of the respondents was 13.34 years. Twenty six percent of the respondents had less than 5 years of total teaching experience and 12% of the respondents had more than 25 years of total teaching experience. The mean age of the respondents was 39.27 years. Twenty three percent of the respondents were less than 30 years old and 15% of the respondents were older than 50 years old. Males constituted 76% (n=96) and females constituted 24% (n=30) of the data sample. The mean number of biotechnology in-service activities or courses taken by the respondents was 1.27. Over forty three percent of all respondents had not attended any in-service or courses related to biotechnology.

1. What is the self-perceived level of knowledge possessed by agricultural educators of integrated science competencies in the Biotechnology and Agriscience Research course? Agricultural educators perceived they were somewhat knowledgeable (M=2.17) on a four point Likert–type scale of competencies in the course (see Table 1). They perceived themselves to be least competent in nucleic acid techniques (M=1.65) and biochemistry concepts related to agriculture (M=1.84). They perceived themselves to be most competent in basic concepts of genetics (M=2.50) and the relationship of biotechnology to agriculture (M=2.52).

2. What is the actual level of knowledge possessed by agricultural educators of integrated science competencies in “Biotechnology and Agriscience Research”? The mean test score for agricultural educators on a 35-item multiple-choice test was 24.09 (69%). More than 44% of the respondents answered less than 70% of the questions correctly.

3. How do North Carolina agricultural educators perceive the importance of “Biotechnology and Agriscience Research” competencies in agricultural education? The participant’s overall mean importance response was 3.87 on a five point Likert-type scale indicating they felt the competencies overall were important to agricultural education. As shown in Table 2, they perceived nucleic acid techniques (M=3.28) and biochemistry concepts related to agriculture (M=3.63) to be the least important.

Table 1
Mean Responses of Self-Perceived Knowledge by Competency

Biotechnology and Agriscience Research Competencies	Mean	S.D.
Explore nucleic acid techniques used in agriculture.	1.65	0.79
Analyze basic concepts in biochemistry related to agricultural Biotechnology.	1.84	0.83
Analyze basic concepts in microbiology related to Agricultural biotechnology.	1.95	0.77
Analyze the potential social and environmental impacts of food Biotechnology processes and products.	2.00	0.76
Examine techniques and biological processes in food science Related to biotechnology.	2.03	0.76
Analyze the potential social and environmental impacts of Environmental biotechnology processes and products.	2.11	0.84
Examine techniques and biological processes in environmental Science related to biotechnology.	2.13	0.82
Analyze the potential social and environmental impacts of plant Biotechnology processes and products.	2.31	0.76
Analyze the potential social and environmental impacts of animal biotechnology processes and products.	2.35	0.80
Examine techniques and biological processes in animal science Related to biotechnology.	2.38	0.80
Examine techniques and biological processes in plant science Related to biotechnology.	2.39	0.77
Analyze basic concepts in genetics related to agricultural Biotechnology.	2.50	0.80
Analyze biotechnology and its relationship to agriculture.	2.52	0.72

4. Which agricultural education program needs do agricultural educators perceive "Biotechnology and Agriscience Research" will fulfill? Agricultural educators felt that 6 of the 7 program needs would be fulfilled by the Biotechnology and Agriscience course by responding with a mean response between 3.5 and 4.5 on a 5-point Likert-type scale (See Table 3). They did not feel that the course would appeal to or help students with lower academic abilities (M=2.33).

5. What is the intent of agricultural educators to adopt the "Biotechnology and Agriscience Research" course within the next six years? Over half (53%) of all agricultural educators indicated they were likely to adopt the course, 29% indicated they were uncertain and 18% indicated they were not likely to adopt the course if barriers did not exist.

Table 2
Mean Responses of the Perceived Importance of Each Competency

Biotechnology and Agriscience Research Competencies	Mean	S.D.
Explore nucleic acid techniques used in agriculture.	3.28	0.95
Analyze basic concepts in biochemistry related to agricultural biotechnology.	3.63	0.96
Analyze basic concepts in microbiology related to agricultural biotechnology.	3.72	0.90
Analyze the potential social and environmental impacts of environmental biotechnology processes and products.	3.79	0.94
Examine techniques and biological processes in food science related to biotechnology.	3.83	0.94
Analyze the potential social and environmental impacts of food biotechnology processes and products.	3.87	0.89
Examine techniques and biological processes in environmental science related to biotechnology.	3.89	0.85
Analyze the potential social and environmental impacts of animal biotechnology processes and products.	3.94	0.88
Analyze the potential social and environmental impacts of plant biotechnology processes and products.	4.00	0.97
Examine techniques and biological processes in plant science related to biotechnology.	4.03	0.98
Examine techniques and biological processes in animal science related to biotechnology.	4.06	0.89
Analyze basic concepts in genetics related to agricultural biotechnology.	4.11	0.90
Analyze biotechnology and its relationship to agriculture.	4.15	0.89

Table 3
Mean Responses of the Perceived Program Need Fulfillment

Program Needs	Mean	S.D.
Appeal to and help students with lower academic abilities.	2.33	0.92
Help gain support of the local administration for agricultural Education.	3.69	0.82
Provide my program with a course that will receive science Credit.	3.82	0.96
Better prepare my students for a future career in agriculture.	3.86	0.76
Help my students make choices concerning controversial Issues dealing with biotechnology.	4.03	0.80
Enhance the image of my agricultural education program.	4.06	0.70
Attract students with higher academic abilities.	4.07	0.85

6. What barriers do agricultural educators perceive to exist in teaching the "Biotechnology and Agriscience Research" course? As shown in Table 4, Agricultural educators perceived equipment (M=3.26) and funding (M=3.08) to be the strongest barriers on a 4-point Likert-type scale. Lack of curriculum (M=2.99), knowledge (M=2.82), and training (M=2.75) were still perceived as barriers but not perceived to be as strong.

Table 4
Mean Response for Barriers to Adopting Biotechnology and Agriscience Research

Barriers To Adopting Biotechnology and Agriscience Research	Mean	S.D.
Lack of administrative support	1.98	0.90
Lack of student interest	2.23	0.77
Not enough time to plan	2.60	0.86
Insufficient teacher inservice and training	2.75	0.90
Lack of teacher knowledge	2.82	0.86
Insufficient curriculum and textbooks	2.99	0.84
Lack of funding	3.08	0.87
Lack of equipment	3.26	0.84

7. If barriers were not present, what is the best predictive model for the dependent variable of the intent of agricultural educators to adopt the "Biotechnology and Agriscience" course as related to the following independent variables; agricultural educators actual level of knowledge of the integrated biotechnology competencies, self-perceived level of knowledge of the integrated biotechnology competencies, perceived importance of the integrated biotechnology competencies, perceived fulfillment of program needs and the demographic factors of age, gender, number of years of teaching experience and number of completed formal biotechnology courses or workshops? Stepwise regression indicated that program needs fulfilled, training, and total years of teaching experience created the best fitting model to explain the dependent variable, intent to adopt. The model accounted for nearly 38% of the variance in North Carolina agricultural educators intent to adopt the course (See Table 5).

Table 5
Best Fitting Predictive Model for Intent to Adopt the Biotechnology and Agriscience Research Course

Model	R	R Square	Adj. R Square	Std. Error
1	.531	.281	.276	1.84
2	.584	.341	.331	1.77
3	.612	.375	.359	1.73

Model 1 Factors: Program Needs
Model 2 Factors: Program Needs, Training
Model 3 Factors: Program Needs, Training, Teaching Experience (fewer years)

Conclusions

Six conclusions were identified based on the purposes and findings of this study. They are presented here with related supporting data.

Agricultural educators accurately perceive that they lack the knowledge to teach the Biotechnology and Agriscience Research course. Nearly half of the agricultural educators surveyed were unable to pass a knowledge test created for high school students based on the Biotechnology and Agriscience Research course. The majority of agricultural educators are also aware of their lack of actual knowledge.

The majority of North Carolina agricultural educators have not participated in training related to biotechnology therefore they are ill prepared to teach concepts related to this emerging technology. Nearly half of all agricultural educators in North Carolina have never attended a biotechnology related course or in-service activity.

Agricultural educators support the importance of teaching biotechnology and recognize the benefits of integrated curriculum in agricultural education. Agricultural educators perceive that biotechnology related content is important and that by offering the course they will enhance the image of their program and better prepare students for the future. They also perceive that by teaching this curriculum their program will attract higher ability students and project a better image.

Agricultural educators perceive that the exterior factors of funding, equipment and teacher knowledge are the largest barriers to adopting integrated science curriculum. Recently, classroom and laboratory activities have been developed to teach the content of the Biotechnology and Agriscience Research course. Teachers are not aware that these new labs require less equipment and expense than those in older curriculum. Teachers do realize that they must possess knowledge of the content in order to teach the course.

The Biotechnology and Agriscience Research course has the necessary support of agricultural educators to propose its' continued inclusion in the North Carolina Workforce Development program of studies. The majority of agricultural educators in North Carolina intend to adopt the curriculum if exterior barriers are not present. New curriculum and resources are being developed that will overcome the perceived barriers of lack of funding and equipment.

Teachers who are most likely to adopt the Biotechnology and Agriscience Research course have fewer years of teaching experience, have attended some biotechnology training and perceive integrated biotechnology curriculum will fulfill their agricultural education program needs. These three independent factors created the best model for predicting agricultural educators intent to adopt the course in this study.

Implications and Discussion

The results of this study are supported in the literature by Locke's (1991) motivational sequence (Figure 1) that encompasses several theories of motivation. The results of this study indicate if teachers perceive the integrated biotechnology curriculum will fulfill a program need, such as improving the image of the program, they are more likely to be motivated to adopt the curriculum. Just as Locke illustrated in the first step of the motivational sequence (Figure 1), a teacher must have a perceived need of the curriculum.

Next according to Locke's motivation sequence, teachers must value the curriculum before they will consider its adoption. In this study, agricultural educators indicated they did perceive the content of the course to be an important subject to be taught in agricultural education.

In Locke's motivational sequence (Figure 1), an agricultural educator's low self-perceived and actual knowledge as described by this study may prevent the teacher from carrying out or performing the goal of adopting the integrated curriculum. Locke hypothesized that the self-efficacy and expectancy of an individual can be determined by their perceived or actual lack of knowledge.

This study did not find perceived or actual knowledge to be a predictor of the intent to adopt curriculum as Rudd and Hillison (1995) found in a study of Virginia middle school teachers. North Carolina agricultural educators may view their lack of knowledge as a factor that is stable and controllable, meaning they feel they possess the ability and administrative support to learn what they need to know to teach the course. Therefore, they possess the confidence to overcome this deficiency by attending training and studying the information.

North Carolina agricultural educators perceive that the Biotechnology and Agriscience Research course will fulfill many program needs but not all individual competencies are valued. Teachers were found to value the importance of individual scientific competencies into agricultural courses in many previous studies such as conducted by Brown et.al. (1998) as in this study. This inconsistency of the value of integrated science curriculum indicates that individual in-service groups should be preassessed to determine their attitudes and value of specific competencies so they can be addressed in training.

Barriers to adopting integrated curriculum as identified by many researchers seem to continue to exist in North Carolina. However, North Carolina agricultural educators seem unsure whether administrative support or student interests are still barriers. Administrative support for this type course may have increased over the past several years due to recent state and federal legislation that encourages curriculum integration. Student interest may be increasing due to the attention biotechnology has recently received in the media.

The implications for this exploratory study should be hopeful and encouraging to those who are attempting to carry out federal and state legislation guidelines that encourage the integration of curriculum. Agricultural educators in North Carolina possess a favorable attitude or perceived value of integrated science curriculum and feel that the integrated curriculum will fulfill program needs. They perceive that funding and equipment barriers do exist; however, educational agencies can create classroom lesson plans and labs that require minimal equipment and funding. The most hopeful aspect of this study is that the majority of the teachers have been motivated enough by their program needs and perceived values to set the goal of adopting the Biotechnology and Agriscience course.

Recommendations for Further Research

The findings of this exploratory study lead to many recommendations for future research. More descriptive research should be conducted to determine if differences exist between each independent factor and agricultural educators' intent to adopt the Biotechnology and Agriscience Research course.

A study of the relationship between agricultural educators actual knowledge of each competency and the value they place on each competency would provide more insight of the perceived value of the content of the course. The actual knowledge of agricultural educators should also be examined more closely to determine in what competency areas they are the most deficient. Graduate programs and other adult educators should carefully study and address these deficiencies and the andragogical processes needed to assist the more experienced teachers in developing self-efficacy and knowledge in these areas.

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