Attitudes Toward Mathematics Integration and Related Professional Development Needs of Outstanding Agricultural Education Instructors

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ABSTRACT

The purpose of this study was to determine the outstanding agricultural teachers' attitudes toward mathematics integration and perceived needs regarding academic integration. Participants of this study were selected by a panel of expert, including teacher educators and state staff, who frequently visit agricultural education teachers and observe their teaching. The panel reached a consensus on 26 outstanding agricultural education teachers. An electronic survey instrument was developed by the researcher. The teachers reported having positive attitudes toward mathematics integration. The agricultural teachers had indicated that mathematics is an integral component of agricultural education and the integration of mathematics is vital; this would indicate that the early-adopters had already entered the Persuasion stage. The positive attitudes toward mathematics integration had led the agricultural education teachers to integrate mathematics would indicating that the early-adopters had also entered the decision stage.

Introduction/Theoretical Base

Agricultural education has been present in public schools since their development in America. Minnesota was the first state to offer secondary agricultural education with the first school organized in 1888. Phipps and Osborne (1988) noted that agricultural education has developed deep philosophical roots, placing a great deal of emphasis on pragmatism. "The practical application and successful transfer of knowledge, skills, and attitudes into real-world settings is the goal of instruction" (p. 19). Phipps and Osborne (1988) further acknowledged that "agricultural education has been cited as an innovative program model for education, in order to maintain an innovative program, efforts have been made to reshape agricultural education programs to ensure their continued value, relevance, vitality, and quality" (p. 14).

The need for educational reform surfaced from the National Commission on Excellence in Education's (1983) report suggesting that American students are falling behind those in other nations. As a result of the report, titled *A Nation at Risk*, high school graduation requirements for academic subjects increased since 1983 (Barrick, 1992; Campbell, Hombo, & Mazzeo, 2000). The increased academic requirements have come at the expense of career and technical education courses (Cetron & Gayle, 1991). Studies have indicated that the increase in academic coursework has not led to an increase in academic achievement (Clune & White, 1992; Hoffer, 1997). National Assessment of Educational Progress scores for mathematics have been relatively flat for the past 30 years (Castellano, Stringfield, & Stone, 2002).

At the same time, traditional mathematics instruction has experienced a great deal of scrutiny. One of the reoccurring themes suggests that in academic programs, students are lectured to about theories and principles, but are never shown how these theories and principles can be applied to real situations (Bottoms & Sharpe, 1996). Researchers have suggested that mathematics as it is being taught in American schools lacks the real-world “connection” and “context” needed to be learned and applied effectively (Britton, Huntley, Jacobs, & Weinberg, 1999; Hoachlander, 1999; Parnell, 1995; Resnick & Hall, 1998; Von Secker & Lissitz, 1999). Mathematics educators have expressed a need to reform mathematics education; one of the themes that emerged is contextually-based learning (Briner, 1999).

Career and technical education courses have also come under scrutiny. Some researchers have expressed concern that skills are taught simply by showing a student how to perform an operation without properly training the student in the theory behind the operation (Parnell, 1996). Warmbrod (1974) stated that “if vocational education assumed its proper role in American education that vocational education must be concerned with the student’s intellectual, social, and cultural development as well as their vocational development” (p. 5). Phipps and Osborne (1988) praised agricultural education; however, they pointed out that one of the image problems associated with agricultural education programs is the emphasis placed on the vocational skills.

Warmbrod (1974) indicated that vocational education should be held accountable for students’ achievement in both academic and vocational skills. Phipps and Osborne (1988) stated that agricultural education should promote meaningful and practical applications of subject matters, such as mathematics. The National Research Council (1988) indicated that in order for secondary agricultural education courses to remain effective, programs must provide a strong emphasis on traditional academic skills.

The lack of application of the theories and principles taught in the academic classroom and the lack of theories and principles associated with the skills taught in the career and technical education courses have left a gap (Parr, 2004). The lack of connection between subject matter in secondary schools has been widely recognized for a number of years (Glasgow, 1997; NASSP, 1996). This gap between practice and theory must be bridged (Parr, 2004). Warmbrod (1974) indicated that theories and principles must be linked with the application and practice. According to a guide for implementing curriculum integration published by The Ohio State University (Center on Education and Training for Employment, 1998), this bridge could come in the form of contextualized learning.

Agricultural education has great potential to deliver relevant curriculum that engages students with hands-on and minds-on learning environments that are rich with real world applications of mathematics (Shinn et al., 2003). Agricultural education, by the very nature of its structure and content, can be used to teach information which may be difficult to teach in other settings (Drawbaugh & Hull, 1971). Phipps and Osborne (1988) linked academic and vocational education, specifically agricultural education stating that:

> Vocational education in agriculture (i.e., agricultural education) is an integral part of public school education and contributes to the general objectives of education. It contributes to the development in students of the ability to think and study and in the ability to solve problems efficiently, which require skill in collecting and interpreting data (p. 9).

Agricultural education provides that authentic context in which students can apply the concepts and skills grounded in mathematics theory (Conroy, Trumbull, & Johnson, 1999). Parr (2004) found that a math-enhanced agricultural curriculum had a positive effect on student math performance, while maintaining the vocational skills associated with the curriculum. According to Bottoms and Sharp (1996), integration of both academic and vocational skills into content areas such as agricultural education holds great potential for enhancing student learning in critical academic, technical, and personal areas.

Miller and Vogelzang (1983) found that agricultural instructors in Iowa supported the inclusion of mathematics concepts in agricultural education. Miller and Gliem (1993a as cited in Hunnicutt, 1994) found that all teachers in Ohio had positive attitudes toward the integration of mathematics in their curriculum, but found that nearly half of the agricultural education teachers studied in Ohio did not coordinate their efforts to integrate mathematics into the agricultural education curriculum with mathematics teachers. Gliem and Warmbrod (1986, as cited in Shinn, 2003) encouraged agricultural education departments to integrate practical mathematics applicable to agriculture into the curriculum. Hunnicutt (1994) indicated that agricultural education instructors in Alabama self-reported that they integrated mathematics into 26-50% of the units in the agricultural education curriculum. Parr (2004) found mathematically enhanced agricultural power and technology courses in Oklahoma had a positive effect on student math performance.

The theoretical perspective that guided the study was the Diffusion of Innovations Theory developed by Rogers (1995). Rogers' diffusion theory has been used for many years to describe innovation diffusion and the adoption or rejection of innovations. Rogers described the five stages of the innovation-decision process as knowledge, persuasion, decision, implementation, and re-invention.

Purpose/Objectives

The purpose of this study was to analyze outstanding agricultural education teachers' attitudes towards mathematics integration. An investigation into the collaboration efforts being made between the agricultural education and mathematics department was also included. The study identified the outstanding teacher perceived needs related to mathematics integration and provided baseline data as the agricultural education instructors in [STATE] increase their integration of mathematics. The study will result in proposed actions to increase mathematics integration into agricultural education curriculums. Research objectives directing this study are:

1. Describe the characteristics of outstanding agricultural education instructors who were nominated by [STATE] agricultural education leaders and the programs in which these instructors teach.
2. Describe the attitudes of the outstanding agricultural education instructors toward the integration of mathematics into the agricultural education curriculum.
3. Describe the perceived needs of the outstanding agricultural education instructors regarding the integration of mathematics into their agricultural education curriculum.

Methods/Procedures

The participants of this study were selected by a panel of experts, including three university teacher educators and three state supervisors, who frequently visit agricultural education teachers and observe them teaching. The panel reviewed the list of teachers nominated to determine if any teachers have been overlooked or if any should be excluded for various reasons. All teachers nominated were determined to be outstanding for the study, however some the nominees included resulted in some in-depth discussions with the nomination panel. The panel reached a consensus on 26 outstanding agricultural education teachers using the following criteria: Reputation of being an excellent teacher, knowledgeable of the agricultural education curriculum in [STATE]; willingness to accept change; provide an in-depth analysis of the questions related to academic integration; willing to complete the study thoroughly; and able to communicate effectively through e-mail. The researcher choose outstanding agricultural education teachers for this study based on the assumption that the outstanding teachers would fall into the persuasion and decision stages.

An electronic survey instrument was developed by the researcher. The survey instrument was created based on the review of the literature regarding academic integration into the career and technical education and agricultural education curricula. Principles of electronic survey design from Dillman's (2000) tailored design method were consulted when constructing the instrument. A field test was administered to a group of 10 Agricultural and Extension Education pre-service teachers while they were student teaching. Upon completion of the field-tested instrument, the pre-service teachers were given the opportunity to provide additional suggestions for improvement of the instrument and report any technical problems to establish face validity. Reviews of responses indicated that only minor revisions were needed and these changes were made prior to data collection. The data collected from the field test allowed the researcher to analyze the reliability of the instrument which yielded a Cronbach's alpha coefficient of $\alpha = 0.868$ and a Spearman-Brown coefficient of $\alpha = 0.874$. However the results from the study yielded a lower reliability score for both Cronbach's alpha and Spearman-Brown (0.64 and 0.66 respectively). The change in reliability scores may be due to the fact that the student teachers in the field study all received prior instruction on academic integration.

Twenty five instruments were completed, resulting in a 96% return rate. The responses from the online survey were automatically downloaded into a Microsoft Excel worksheet. The time allotted for data collection was three weeks as recommended by Dillman (2000) and Truell, Bartlett, and Alexander (2002). The survey data were analyzed using the Statistical Package for the Social Sciences (SPSS) 13.0 Student Version for Windows. Data associated with research question were analyzed using descriptive statistics.

Results/Findings

Research objective one was aimed at determining demographic information for the respondents. The outstanding agricultural education teachers had range of 5 to 34 years of teaching experience, with a mean of 17 years. However, 44% of the respondents had 5- 10 years of teaching experience and 44% of the respondents had 20 or more years of experience. The mean age of the 25 outstanding agricultural education teachers was 40 (SD = 9.08) with a range of 29 to 59. Caucasians accounted for 96% of the respondents, while there was only one African American. Fifty-six percent of the respondents were males and 44% were females.

A bachelor's degree and master's degree were the only two levels of education indicated by the outstanding agricultural education teachers. The findings indicated that 52% had master's degrees, while 48% had bachelor's degrees. All 25 outstanding agricultural teachers had an endorsement in agricultural education, while three had an endorsement in science and one had an endorsement in both mathematics and business. Seventeen (68%) of the respondents indicated holding a Collegiate Professional License while respondents with a Postgraduate Professional License accounted for the other eight (32%). More then three-fourths of the respondents (76%) taught at the high school level and 24% taught at the middle school level. Ninety-two percent of respondents indicated membership in the Virginia Association of Agricultural Educators (SAAE), the state professional association for agricultural education teachers. The frequencies and percentages for selected teacher characteristics are listed in Table 1.

Sixty percent of the respondents taught in an urban school, while 40% of the respondents taught in a rural school. The largest number of departments (n=10, 40%) had two teachers as indicated by the respondents. The respondents (n=25) reported a range of 62 to 440 students enrolled in their agricultural education programs with a mean of 188 students (*SD*= 76.67). Only three respondents indicated that students receive academic credit outside of agricultural education for courses completed in that department. Two teachers said that students received a science elective credit for completing an agricultural education course while one indicated students receive a forestry credit. A majority (22) indicated that students did not receive any academic credit for courses taught in their department. Forty percent of the respondents' schools utilized the A/B block scheduling system. Schools that used the 4x4 block system made up 28%, and the seven-period system was reported by 24% of the respondents. The frequencies and percentages for selected program characteristics are listed in Table 3.

Table 1

Summary of Selected Teacher Characteristics (n=25)

		f	%
Level of Education	Bachelor's Degree	12	48
	Master's Degree	13	52
Gender	Male	14	56
	Female	11	44
Ethnicity	African American	1	4
	Caucasian	24	96
Grade Level Taught	Middle School	6	24
	High School	19	76
Member of VAAE	Yes	23	92
	No	2	8

Research objective two was aimed at determining attitudes toward mathematics integration for the respondents. The maximum range of attitude scores was 1 to 5, with 1 indicating the least favorable attitude and 5 representing the most favorable attitude. The statement that "agricultural education provides an excellent avenue to teach mathematics" yielded the highest mean score of 4.44 (*SD*=0.51) and "mathematics is an integral component of agricultural education" was second with a mean score of 4.36 (*SD*=0.76). The statement "mathematics integration is not important to the agricultural education curriculum" yielded the lowest mean of 1.72 (*SD*=0.84). Note that disagreement with a negative statement indicates a favorable attitude.

Table 3

Summary of Selected Program Characteristics (n=25)

		f	%
Location of School	Urban	15	60
	Rural	10	40
Agricultural Education Teachers on Campus	1	7	28
	2	10	40
	3	6	24
	4	2	8
Type of School Schedule	7 Period	6	24
	8 Period	2	8
	A/B Block	10	40
	4x4 Block	7	28

The respondents had negative attitudes toward students' ability to learn mathematics in the traditional settings with a mean score of 2.56 (*SD*=1.00). They also had negative attitudes toward students not being capable of understanding difficult mathematics concepts used in the agricultural industry, with a mean score of 2.24 (*SD*=0.72). The agricultural education teachers' attitudes toward mathematics integration are included in Table 4.

Table 4

Agricultural Education Teachers Attitudes toward Mathematics Integration

Statements	M	SD
Agricultural education provides an excellent avenue to teach mathematics in an applied context.	4.44	0.51
Mathematics is an integral component of agricultural education.	4.36	0.76
Students learn mathematics best in applied learning environments.	4.28	1.14
The curriculum I teach can aid the students with the mathematics section of the Virginia Standards of Learning.	4.16	0.62
I believe I should integrate mathematics into my curriculum.	4.12	0.60
I can integrate more mathematics skills into my agricultural education curriculum than what I am currently integrating.	4.04	0.54
Agricultural education is a mathematics-rich content area.	4.00	0.71
I purposely integrate mathematical concepts into my lessons.	3.92	0.76
I enjoy linking mathematical concepts to agricultural settings.	3.79	0.83
Student achievement increases with the integration of mathematics into the	3.75	0.85

agricultural education curriculum.		
The Standards of Learning have played a role in the decreasing number of students enrolled in the agricultural education department.	3.60	1.00
There are adequate curriculum materials available to integrate mathematics into my curriculum.	3.08	0.91
Students do not want to learn about mathematics in my courses.	2.88	1.04
If I increase the academic rigor of my courses, the students will elect to not enroll in my courses.	2.76	0.97
Mathematics teachers in my school recognize the value agricultural education has for teaching mathematics.	2.72	1.02
Students learn mathematics best in a traditional mathematics course.	2.56	1.00
My students are not capable of understanding difficult mathematics concepts used in the agricultural industry.	2.24	0.72
Mathematics should be taught in the mathematics department not in the agricultural education department.	1.76	0.72
Mathematics integration is not important to the agricultural education curriculum.	1.72	0.84

Note. Strongly Disagree = 1, Disagree = 2, Uncertain = 3, Agree = 4, Strongly Agree = 5

The respondents indicated favorable attitudes toward professional development regarding mathematics integration. The desire to see how other agricultural education teachers have integrated mathematics yielded the highest mean score of 3.84 (*SD*=0.55). The statement about reviewing a curriculum that integrates mathematics into agricultural education yielded the second highest mean score of 3.80 (*SD*=0.82). The lowest mean scores were for items related to the desire to develop a curriculum integrating mathematics (3.00), teaching an applied mathematics course (3.16), and participating in classes (3.24) or workshops (3.36) related to mathematics integration. Responses to the need for professional development related to mathematics integration are summarized in Table 5.

Table 5

Agricultural Education Teachers Needs Regarding Academic Integration

	M	SD
I am interested in how teachers have integrated mathematics into their agricultural curricula.	3.84	0.55
I would be interested in reviewing a curriculum for a mathematics course that is applied to agricultural education.	3.80	0.82
I have participated in professional development activities related to academic integration.	3.68	0.90
I am interested in learning how to teach mathematics in applied contexts.	3.68	0.85
I would increase my integration of mathematics if the curriculum specialists develop more teaching materials that integrate mathematics into the agricultural education curriculum	3.68	0.90
I would like to participate in additional workshops related to mathematics integration.	3.40	0.82

I would be interested in an in-service workshop on mathematics integration that would include the mathematics instructors from my school.	3.36	0.70
I am interested in taking courses on mathematics integration in agricultural education.	3.24	0.83
I would teach a course focusing on "mathematics applied to agriculture" if students could receive mathematics credit for the course?	3.16	1.18
I would be interested in developing a curriculum for a mathematics course applied to agricultural education.	3.00	1.04

Note. Strongly Disagree = 1, Disagree = 2, Uncertain = 3, Agree = 4, Strongly Agree = 5

Conclusions

The agricultural education teachers in this study had a positive attitude toward the integration of mathematics. They concur that agricultural education provides an excellent avenue to teach mathematics and that mathematics is an integral component of agricultural education. The study was helpful in identifying at what stage the agricultural education teachers in Virginia were within Rogers (1995) stages of adoption.

The agricultural teachers had indicated that mathematics is an integral component of agricultural education and the integration of mathematics is vital; this would indicate that the early-adopters had already entered the Persuasion stage. The positive attitudes toward mathematics integration had led the agricultural education teachers to integrate mathematics indicating that the early-adopters had also entered the decision stage. However, the agricultural educators acknowledged that they could integrate more mathematics into their curriculum indicating that they had not moved into the re-invention stage at this time.

The agricultural education teachers wanted to see how others have integrated mathematics and need curriculum that integrates mathematics and utilizes real-life applications and problem-solving activities. The teachers also indicated that they would increase their level of mathematics integration if curriculum specialists would develop applicable materials. Ultimately the Agricultural Education teachers in Virginia are open to academic integration and more specifically mathematics integration. The outstanding teachers need help in order to be successful and this can start by identifying teachers who integrate math at the highest levels and have them serve as peer mentors and/or workshop presenters.

Recommendations for Implementation

The following recommendations are based upon the findings and conclusions of this study.

1. Agricultural educators should develop lessons, skill sheets, and modules that can be placed on the National Association of Agricultural Educators (NAAE) "Communities of Practice" website for dissemination to other practitioners throughout the United States.

2. The Association of Career and Technical Education (ACTE) should provide more content specific examples related to all areas within the Agricultural Education Curriculum utilizing the Math in CTE model.
3. Agricultural education practitioners should continue to emphasize the importance of academic integration into the agricultural education curriculum to improve student learning. The Agricultural Education Teacher and/or the CTE department should be the individuals that take the initiative by taking the first step to work with the math experts in their school building.
4. Agricultural education practitioners should continue to link academic standards of learning to each agricultural education competency. Agricultural educators should take it upon themselves to reinforce the Virginia Standards of Learning or similar standards in other states to help students connect the principles to real-life applications.
5. Agricultural education curriculum specialists should continue to develop integrated learning activities that reinforce the academic theories and principles with agricultural education applications.
6. State agricultural education leaders should develop workshops that utilize hands-on activities that integrate academics. The workshops should place the teachers in the student role. The workshops should be practical, allowing the teachers to take what they learned in the workshop and implement it into their lessons.
7. Textbook companies that develop teacher education materials need to develop more materials that emphasize the academic theories and principles that are being integrated into the agricultural mechanization content; specifically, the materials should utilize team activities, real-life applications, and revamp current laboratory activities.

Recommendations for Further Research

The following recommendations are based upon the findings and conclusions of the study.

1. Investigate pre-service teachers' attitudes and academic problem-solving abilities before and after completing an agricultural education course that teaches strategies for academic integration.
2. Investigate the integration of other academic areas such as English, social studies, and foreign languages into agricultural education.
3. Assess students' attitudes toward receiving mathematics credit for completing an agricultural education course that integrates mathematics.
4. Investigate mathematics teachers' attitudes toward mathematics integration into the agricultural education curriculum and their attitudes toward collaboration with agricultural education teachers.
5. Conduct a national needs analysis for professional development of agricultural education teachers regarding academic integration.
6. Identify the incentives and barriers to academic integration in agricultural education.

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