SELF-REPORTED LEVEL OF MATHEMATICS INTEGRATION OF OUTSTANDING VIRGINIA AGRICULTURAL EDUCATORS

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Abstract

This study is a part of a larger investigation which focused on determining the attitudes, perceptions, level of integration, and perceived needs of outstanding agricultural education teachers. The purpose of this study was to determine the outstanding agricultural teachers' level of mathematics integration into each agricultural course taught and provided baseline data as the agricultural education instructors' increase their integration of mathematics. The participants of this study were selected by a panel of experts who frequently visit agricultural education teachers and observe them teaching. The panel reached a consensus on 26 outstanding agricultural education teachers. An electronic survey instrument was developed by the researcher. The teachers reported integrating mathematics in a range from 0 to 75% in individual agricultural courses.

Introduction/Theoretical Framework

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. By 1910, Virginia promoted agricultural education through Congressional district agricultural schools. A total of 30 states had agricultural education courses established in the public schools systems prior to the Smith Hughes Act, which was passed in 1917 (Phipps & Osborne, 1988). The Smith-Hughes Act provided funding to promote and establish agricultural education courses.

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). Mathematical 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 matter, 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 mathematic 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.

Drosjack (2003) reported that fewer than one in every three students nationally are able to do math at a proficient level. The Bayer Corporation (2003) found that 9 out of 10 U.S. citizens are concerned that today's students may not have the mathematical skills to produce the excellence required for homeland security and economic leadership in the 21st century. Students today require strong mathematical knowledge and skills in order to pursue higher education, compete in the technology driven workforce, and be informed citizens (VDOE, 2005).

Agricultural education instructors are required by the standards set forth in the Carl D. Perkins Act of 1998 to integrate academics into the agricultural education curriculum.

Miller and Gliem (1993a as cited in Hunnicutt, 1994) 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 attempt 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.

Purpose of the Study

The purpose of this study was to determine the outstanding agricultural teachers' level of mathematics integration into each course currently taught. This study provided baseline data as the agricultural education instructors in Virginia increase their integration of mathematics. The study resulted in proposed actions to increase mathematics integration into agricultural education curriculums. Research objectives investigated in this study were:

1. Describe the characteristics of outstanding agricultural education instructors who were nominated by Virginia agricultural education leaders and the programs in which these instructors teach.
2. Describe the self-reported level of integration of mathematics by each instructor and across instructors for each course taught.

Methods/Procedures

The participants of this study were selected by a panel of experts who frequently visit agricultural education teachers and observe them teaching. The panel was composed of two agricultural education teacher educators, the Director of Agricultural Education in the State Department of Education, and two State agricultural education curriculum specialists. An email message was sent to the panel of experts requesting nominations of 10 outstanding agricultural education classroom teachers using the following criteria: knowledgeable of the agricultural education curriculum; willing to accept change; provide an in-depth analysis of the questions; willing to complete the study thoroughly; and able to communicate effectively through email. After compiling the responses from the panel of experts, a list of nominees was created based on those who were identified by the expert panel. The nomination list was then submitted to the panel of experts for final approval. The panel reached a consensus on 26 outstanding agricultural education teachers. An email was then sent to all prospective participants to inform them of their nomination.

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 group of 10 Agricultural and Extension Education pre-service teachers completed the instrument while they were student teaching in order to field test the instrument. 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.

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. Frequencies, percentages, means, and ranges were calculated for each outstanding agricultural education instructor's overall integration of mathematics and for each agricultural mechanics course taught. The number of instruments that were completed was 25, resulting in a 96% return rate.

Results/Findings

Research objective one was aimed at determining demographic information for the respondents. The outstanding agricultural education teachers had range of 5-34 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 only a bachelor's degree. 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 than 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 (VAAE), the state professional association for agricultural education teachers. The frequencies and percentages for selected teacher characteristics are listed in Table 1.

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

A majority (68%) of the respondents completed 4-5 mathematics courses in high school. A majority (56%) of the respondents did not complete a mathematics course at a two-year college and/or community college, but a range or 1-4 courses at this level was reported by 34% of the agricultural education teachers. Forty-eight percent of the respondents completed 2 to 3 mathematics courses at a four-year college or university. The number of courses completed by the outstanding agricultural teachers is indicated in Table 2.

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. Departments with only one agricultural education teacher made up 28% and three teacher departments were reported by 24%. 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 agricultural education teachers 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 2
Mathematics Courses Completed by Respondents (n=25)

		f	%
Mathematics Courses Completed in High School	1	1	4
	3	2	8
	4	11	44
	5	1	4
	6	4	16
Mathematics Courses Completed in Community College	0	14	56
	1	4	16
	2	2	8
	3	2	8
	4	1	4
Mathematics Courses Completed at University	0	5	20
	1	2	8
	2	6	24
	3	6	24
	4	3	12
	6	2	8

Note: Totals do not equal 100% due to non-respondents.

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 agricultural education teachers (n=24) reported a mean of 21.63% of course content that utilizes mathematics in their curriculum, with a standard deviation of 11.34. The respondents indicated a range of 4 to 47% of mathematics integrated per teacher. The teachers reported integrating mathematics in a range of 2 to 75% in individual agricultural education courses. The 24 teachers reported teaching 29 different courses. There were seven courses that were taught by only one teacher and six courses by only two teachers. There were seven courses that were taught by at least five teachers, with agricultural mechanics and basic plant science I being taught by the most teachers (10). The seven courses taught by at least five different teachers had a range of 8.60 to 26.43 mean percentage of mathematics integration. Information for each course taught is presented in Table 4.

There were only three courses that were taught by at least two agricultural education teachers that had a mean percentage of integration over 30%; all three courses were agribusiness courses. The teachers of the five agricultural mechanics courses reported integrating mathematics at the second highest level ranging from 18.33 to 26.43%. The floriculture, floral design, and horticulture courses yielded the lowest percentages of integration, ranging from 5 to 8.6%. However, landscaping yielded 20% of mathematics integration and greenhouse management yielded 75% integration. The agricultural mechanics and Basic Plant Science I course that was taught by the most agriculture teachers yielded 22.9% mathematics integration.

Conclusions

The results of this study also suggest that there is an interest in academic integration within the agricultural education curriculum by these outstanding agricultural education teachers. This study may be helpful for state leaders in agricultural education by providing the self-reported level of mathematics integration among these selected outstanding agricultural education teachers. The mean indicated that the typical agricultural education teacher in this study integrated mathematics into 23% percent of their lessons.

It was noted that the percentage of integration of mathematics is lower than the percentage of integration among agricultural education teachers in Alabama as reported by Hunnicutt (1994). However, Hunnicutt gave the agricultural education teachers the option to select a range 0 to 25, 26 to 50, 51 to 75, and 76 to 100 in their total curriculum; the researchers had the teachers report the level of integration for each agricultural education course they taught. It should also be noted that by breaking down each course taught allowed the researchers to identify the individual courses have been utilized to integrate mathematics. This also provides the state curriculum specialists with the breakdown of the courses that teachers are struggling to integrate mathematics in as well.

The results of this study are also helpful in acknowledging that there was a negative relationship between percentage of mathematics integration and years of teaching and age. The younger agricultural education teachers tended to integrate mathematics at a higher percentage than older agricultural education teachers. This could help teacher education program leaders recognize that their efforts to help pre-service teachers to integrate mathematics may have helped thus far. This also provides teacher education programs with the benchmark data to know that additional efforts to integrate academics into the agricultural education curriculum. This data also provides insight to curriculum specialists to identify the needs among agricultural education teachers regarding mathematics integration.

Table 4

Percentage of Mathematics Integrated per Course (n=25)

Course Number	Title	N	Minimum	Maximum	Mean	SD
8035	Greenhouse Plant Production and Management	1	75	75	75.00	0.00
8024	Agricultural Business Operations IV	2	45	50	47.50	3.54
8022	Agricultural Business Fundamentals III	3	40	50	45.00	5.00
8026	Agricultural Business Operations V	1	45	45	45.00	0.00
8073	Applied Agricultural Concepts	1	40	40	40.00	0.00
8014	Operating the Farm Business IV	4	25	50	33.75	11.09
8042	Forestry, Wildlife, and Soil Management IV	3	20	40	28.33	10.41
8010	Agricultural Production Technology III	3	15	45	26.67	16.07
8008	Agricultural Mechanics and Basic Animal Science II	7	10	50	26.43	12.33
8004	Agriscience and Technology	6	15	50	25.00	13.04
8082	Small Engine Repair	3	25	25	25.00	0.00
8016	Introduction to Power, Structural, and Technical Systems	7	20	35	23.57	5.56
8006	Agricultural Mechanics and Basic Plant Science I	10	10	50	22.90	12.33
8012	Agricultural Production Management IV	3	15	30	21.67	7.64
8036	Landscaping	2	15	25	20.00	7.07
8003	Agriscience Exploration	8	15	20	18.75	2.312
8018	Agricultural Power Systems	3	10	35	18.33	14.43
8040	Introduction to Natural Resources III	4	0	40	17.50	16.58
8084	Small Animal Care II	2	5	20	12.50	10.61
8088	Veterinary Science	2	5	20	12.50	10.61
8080	Equine Management Production	3	5	20	11.67	7.64
8002	Introduction to Agriscience	6	5	15	9.17	3.76
8034	Horticulture Science	5	3	15	8.60	4.72
8038	Floriculture	2	5	12	8.50	4.95
8065	Exploratory Agriculture	1	8	8	8.00	0.00
8000	Floral Design I	1	5	5	5.00	0.00
90916	Leadership and Communication	2	0	5	2.50	3.54
8083	Small Animal Care I	1	2	2	2.00	0.00

Recommendations for Implementation

The following recommendations are based upon the findings and conclusions of this study. Agricultural education practitioners should continue to emphasize the importance of academic integration into the agricultural education curriculum to improve student learning. 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 State Standards of Learning or similar standards in other states to help students connect the principles to real-life applications. Agricultural education curriculum specialists should continue to develop integrated learning activities that reinforce the academic theories and principles with agricultural mechanization applications. State agricultural and mathematics 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.

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. State educational leaders should develop a standardized curriculum that includes generic lesson plans that utilize all of the State Standards of Learning and workplace readiness skills associated with each lesson. These lessons will help in-service teachers who need help integrating academics into their lessons. State professional organizations should invite agricultural education teachers from programs that offer mathematics credit through agricultural education courses to serve as workshop presenters to share how they integrate mathematics.

Recommendations for Further Research

The following recommendations are based upon the findings and conclusions of the study. Conduct an in-depth study that investigates the lessons plans of in-service teachers to determine to what extent they are integrating mathematics, where they are emphasizing mathematics, and where they could be integrating mathematics. Investigate the achievement levels of students who receive applied mathematics instruction vs. traditional mathematics instruction in the schools that are currently offering mathematics credit for students who complete a mathematics applied to agriculture course. Conduct a study that investigates the pre-service teachers' attitudes and academic problem-solving abilities before and after completing an agricultural education course that integrates academics. Conduct a study that investigates the level of academic integration by teachers after they participate in workshops that emphasize academic integration.

Investigate the integration of other academic areas such as English, social studies, and foreign languages. Conduct a study to investigate students' attitudes toward receiving mathematics credit for completing an agricultural education course that integrate mathematics. Conduct a study that investigates mathematics teachers' attitudes toward mathematics integration into the agricultural education curriculum and their attitudes toward mathematics integration into the agricultural education curriculum and their attitudes toward collaboration with the agricultural education teachers. Replicate this study comparing agricultural education teachers who have been teaching since 1988 to those agricultural education teachers who have been teaching prior to 1988, when the name vocational agriculture was changed to agricultural education.

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