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# PRESERVICE AGRICULTURAL EDUCATORS' ABILITY TO SOLVE AGRICULTURALLY RELATED MATHEMATICS PROBLEMS

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## Abstract

*The ability to apply academic skills to agriculture is increasingly important. Even so, studies have shown that students and teachers of agricultural education lack competence in solving agriculture-related mathematics problems. The purpose of this correlational study was to explain variance in the mathematical problem-solving ability of preservice agricultural educators. Findings show a lack of competence in mathematical problem-solving among the preservice agricultural educators in the study. Also, preservice educators who achieved higher scores on the problem-solving test had completed fewer college mathematics courses, were more likely to have taken advanced mathematics courses, and possessed higher ACT math scores. A previously tested approach to teaching mathematical problem-solving in the context of agriculture was recommended. Additionally, the importance of recruiting undergraduate students with the aptitude needed to apply basic math and other academic principles to agriculture was emphasized. Further research is needed to more precisely isolate the nature of the problem. Do preservice agricultural educators lack mathematics skills, or do they lack the ability to conceptualize problems and devise appropriate solutions?*

The purpose of vocational education is to make youth employable, and employability can be accomplished best when vocational education complements academic education. Academic and vocational curricula should be integrated and their coequal importance recognized in order that students can see a connection between the academic skills that they are required to learn and the world of work in which they will be required to apply those skills (Educational Testing Service, 1991; National Commission on Secondary Vocational Education, 1984; The Secretary's Commission on Achieving Necessary Skills, 1991; Wade and Williams, 1988; William T. Grant Foundation on Work, Family, and Citizenship, 1988).

According to the Committee on Agricultural Education in the Secondary Schools (1988, p. 35), "ongoing efforts should be expanded to upgrade the scientific and technical content of vocational agriculture courses". What is being done to address concerns raised by educational reformers and the recommendations made specifically for agricultural education? Miller and Gliem (1993a) reported that considerable support existed for the infusion of academic skills, particularly those related to mathematics, into secondary agriculture programs. However they concluded that the extent to which curricula integration is successful will depend upon the initiative of secondary agricultural educators.

Several studies (Persinger & Gliem, 1987; Gliem & Elliot, 1988; Gliem, Lichtensteiger, & Hard, 1987; Gliem & Warmbrod, 1985, 1986; Miller & Gliem, 1993b) have been conducted to determine whether secondary students, undergraduates in agricultural education, and teachers of agricultural education were proficient in applying mathematics concepts to agriculture-related problems. Findings have consistently

indicated that secondary and undergraduate students as well as teachers were not proficient in solving agriculture-related mathematics problems.

In light of recent efforts to emphasize the application of academic principles to agriculture, are preservice agricultural educators now better equipped to apply mathematics and other academic competencies to agriculture? What variables can explain differences among preservice agricultural educators in their ability to solve agriculture-related mathematics problems? Previous research (Persinger et al., 1987; Gliem et al., 1988; Gliem et al., 1985, 1986) has identified the number of mathematics courses completed, and ACT math score as promising explanatory variables.

## Purpose and Objectives

The purpose of this correlational study was to explain variance in the mathematical problem-solving ability of preservice agricultural educators. The study was guided by the following research objectives and hypotheses:

Research Objective

1. Describe selected background characteristics of preservice agricultural educators.

2. Describe preservice agricultural educators' ability to solve agriculture-related mathematics problems.

Research Hypotheses

1. The number of college mathematics courses completed by preservice agricultural educators will explain a significant proportion of the variance in mathematical problem-solving ability beyond that accounted for by gender, grade point average, highest level of mathematics course work completed, and ACT math score.

2. ACT math scores for preservice agricultural educators will explain a significant proportion of the variance in mathematical problem-solving ability beyond that accounted for by gender, grade point average, highest level of mathematics course work completed, and number of mathematics courses completed.

## Procedures

Population and Sample

The population for the study was preservice educators majoring in agricultural education at The Ohio State University. The sample (n=49) consisted of preservice educators enrolled in a methods of teaching agriculture course during the spring quarters of 1992 and 1993.

Instrumentation

The mathematical problem-solving test consisted of 15 word problems written in a agricultural context (Agricultural Business, Animal Science, Agronomy, Agricultural Mechanics, Poultry Science, and Horticulture), and was developed by Miller (1992). Content and face validity were assessed by a panel of experts consisting of teacher educators in agriculture and mathematics. Cronbach's alpha was used to estimate the reliability of the test, yielding a coefficient of .85.

Data Collection

The mathematical problem-solving test was administered by the researchers during a regularly scheduled session of the methods of teaching agriculture class. The preservice educators were provided pencils and calculators and were allowed approximately 45 minutes to complete the test.

Analysis of Data

All data were analyzed with the SPSS/PC+ personal computer program. The alpha level was set a priori at .05, and Davis' (1971) conventions were used to describe all relationships. In order to control the selection threat inherent in the static group comparison design, hierarchical regression analysis was used to test the research hypotheses.

## Results

The preservice educators had a mean grade point average of 2.87 with a standard deviation of .44 and possessed a mean ACT math score of 19.88 with a standard deviation of 5.80. On average, the preservice educators had completed 2.16 college mathematics courses with a standard deviation of 1.09 (Table 1).

Types of mathematics courses completed by the preservice educators were collapsed into three categories. Basic mathematics courses included: basic college math, pre-college math I, pre-college math II. College algebra courses were considered intermediate, while elementary functions and calculus courses were considered advanced. Of the preservice agricultural educators studied, 37.2% (16) completed mathematics courses that were categorized as basic. Most preservice educators, 79.1% (34), completed intermediate mathematics courses while 53.5% completed advanced mathematics course work (Table 2).

Preservice educators were assigned to groups based upon the highest level (basic, intermediate, advanced) of mathematics course work completed. Table 3 shows that basic mathematics was the highest level of college mathematics course work completed by 2.3% (1) of the preservice educators, while 44.2% (19) of the preservice educators had intermediate math as the highest level of college mathematics course work completed. The remaining 53.3% (23) of preservice educators had taken advanced mathematics course work.

The preservice agricultural educators' scores on the 15 item mathematical problem-solving test ranged from a low of 0 (0.0%) to a high of 13 (87%). Most (87.8%) of the preservice educators correctly solved fewer than 9 (60.0%) of the problems. Table 4 shows the distribution of scores on the problem-solving test by year. The distribution of scores on the problem-solving test

Table 1. Descriptive Statistics for Number of Mathematics Courses Completed, ACT Math Score, and Grade Point Average

| | 1992 | | 1993 | | Total | |
|---|---|---|---|---|---|---|
| Variable | Mean | S. D. | Mean | S. D. | Mean | S. D. |
| GPA | 2.79 | .43 | 2.94 | .44 | 2.87 | .44 |
| ACT Math Score | 20.53 | 5.49 | 19.33 | 6.13 | 19.88 | 5.80 |
| Number Math Courses | 2.18 | 1.07 | 2.15 | 1.12 | 2.16 | 1.09 |

Table 2. Types of Mathematics Courses Completed by Preservice Educators

| | 1992 | | 1993 | | Total | |
|---|---|---|---|---|---|---|
| Type | f | % | f | % | f | % |
| Basic | 7 | 41.2 | 9 | 34.6 | 16 | 37.2 |
| Intermediate | 14 | 82.4 | 20 | 76.9 | 34 | 79.1 |
| Advanced | 8 | 47.1 | 15 | 57.7 | 23 | 53.5 |

Table 3. Highest Level of Mathematics Course Work Completed by Preservice Educators

| | 1992 | | 1993 | | Total | |
|---|---|---|---|---|---|---|
| Level | f | % | f | % | f | % |
| Basic | 1 | 5.9 | 0 | 0.0 | 1 | 2.3 |
| Intermediate | 8 | 47.1 | 11 | 42.3 | 19 | 44.2 |
| Advanced | 8 | 47.1 | 15 | 57.5 | 23 | 53.3 |

was positively skewed with a mean of 5.57 (37%) and a standard deviation of 2.92.

Pearson correlations were calculated to describe the relationships between preservice agricultural educators' ability to solve agriculture-related mathematics problems and grade point average, ACT math score, and number of college level mathematics courses completed. Point biserial correlations were calculated to describe the relationships between mathematical problem-solving ability and gender and types (basic, intermediate, advanced) of mathematics courses completed.

The relationships ranged in magnitude from negligible to substantial (Table 5). The relationships between mathematical problem-solving ability and grade point average and gender were negligible. A low negative association was found between problem-solving ability and whether preservice educators had taken intermediate mathematics courses while a low positive association was found between problem-solving ability and whether preservice educators had taken advanced mathematics courses.

A moderate association existed between problem-solving ability and the number of mathematics courses completed. There was a substantial positive relationship between ACT math score and problem-solving ability while a substantial negative association existed between problem-solving ability and whether students had taken basic mathematics courses. Preservice educators with higher scores on the problem-solving test had taken advanced mathematics courses in addition to or instead of basic and intermediate math, had completed fewer college mathematics courses, and possessed higher ACT math scores.

Hierarchical regression was used to test the first hypothesis. A set of four extraneous variables (gender, grade point average, highest level of mathematics course work, and ACT math score) explained 38% of the variance in preservice educators' mathematical problem-solving ability. Number of mathematics courses completed by the preservice educators accounted for an additional three percent of the variance in problem-solving ability beyond that explained by the extraneous variables (Table 6). The variance uniquely accounted for by number of mathematics courses completed was not statistically significant and the research hypothesis was rejected.

Hierarchical regression was also used to test the second hypothesis. A set of four extraneous variables (gender, grade point average, highest level of mathematics course work, and number of mathematics courses completed) explained 32% of the variance in preservice educators' mathematical problem-solving ability. Preservice educators' ACT math score accounted for an additional nine percent of the variance in problem-solving ability beyond that explained by the extraneous variables (Table 6). The variance uniquely accounted for by ACT math score was statistically significant and the research hypothesis was accepted.

Table 4. Preservice Teacher's Score on the Mathematical Problem-Solving Test

| | | 1992 | | 1993 | | Total | |
|---|---|---|---|---|---|---|---|
| Raw Score | % Correct | f | % | f | % | f | % |
| 0-3 | 0-20 | 5 | 25.0 | 7 | 24.1 | 12 | 24.5 |
| 4-7 | 27-47 | 9 | 45.0 | 17 | 58.7 | 26 | 53.1 |
| 8-11 | 53-73 | 4 | 20.0 | 4 | 13.8 | 8 | 16.3 |
| 12-15 | 80-100 | 2 | 10.0 | 1 | 3.4 | 3 | 6.1 |

Grand Mean = 5.57; S.D. = 2.92

Table 5. Summary of Relationships Between Ability to Solve Agriculture Related-Mathematics Problems and Selected Variables

| Variable | X1 | X2 | X3 | X4 | X5 | X6 | X7 | Y1 |
|---|---|---|---|---|---|---|---|---|
| GPA (X1) | 1.00 | .11 | .02 | .30 | -.33 | -.12 | .19 | .02 |
| ACT Math (X2) | | 1.00 | -.35 | -.17 | -.63 | -.34 | .40 | .56 |
| No. of Math Courses (X3) | | | 1.00 | -.04 | .37 | .48 | .26 | -.31 |
| Gender (X4)[a] | | | | 1.00 | -.01 | .15 | -.29 | -.01 |
| Type of Math | | | | | | | | |
| Basic (X5)[b] | | | | | 1.00 | .28 | -.44 | -.60 |
| Intermediate (X6)[b] | | | | | | 1.00 | -.37 | -.23 |
| Advanced (X7)[b] | | | | | | | 1.00 | .28 |
| Problem-solving Score (Y1) | | | | | | | | 1.00 |

[a] 0 = male; 1 = female; [b] 0 = did not complete this type of course; 1 = completed this type of course

Table 6. Regression of Number of Mathematics Courses Completed and ACT Math Score on Mathematical Problem-Solving Ability (Hierarchical Entry)

| Variable | K | $R^2$ Change | F |
|---|---|---|---|
| No. of Math Courses | 4 | .03 | 1.64 |
| ACT Math Score | 4 | .09 | 4.77* |

* $p < .05$; K = number of variables statistically controlled

## Conclusions and Recommendations

The preservice agricultural educators were not capable of applying basic mathematics skills to agricultural problems. This finding supports those of other studies (Gliem et al., 1986; Gliem et al., 1987) involving undergraduates. Can the agricultural education profession make progress towards infusing science and mathematics into the curriculum, when the people who will likely determine the success or failure of curricula integration are not capable of applying basic skills to agriculture-related problems?

Serious efforts should be made to improve the basic skills of preservice agricultural educators. Results of this and related studies suggest that recommending more mathematics courses of any level would not be prudent. Perhaps a change in how mathematical problem-solving is traditionally

taught offers a more defensible approach to improving the mathematical problem-solving skills of preservice agricultural educators. Research conducted by Gliem et al. (1987) demonstrated that students who enrolled in an applied mechanics course, which focused on mathematical problem-solving, gained competence in mathematical problem-solving and retained this increased competence over time. Therefore, it is recommended that mathematical problem-solving be incorporated into the technical agriculture courses taken by undergraduates in agricultural education.

Preservice agricultural educators with higher ACT math scores tended to score higher on the mathematical problem-solving test. This finding was consistent with those of other researchers (Gliem et al., 1988; Gliem et al., 1987; Miller et al., 1993b). Types of mathematics courses completed were related to problem-solving ability and to ACT math scores. It seems reasonable to suggest that the types of math courses taken by undergraduates is partly determined by their mathematical aptitude. Students who have lower aptitudes generally enroll in lower level mathematics courses. This often results in their taking more college mathematics courses to satisfy the university's minimum requirement and may explain the negative association between problem-solving ability and the number of mathematics courses completed. With the increasing emphasis on changing secondary agriculture programs to reflect a more academic base, it becomes increasingly important for teacher education programs to recruit students with the aptitude necessary to apply basic math and other academic principles to agriculture.

Further research is needed to carefully isolate the nature of the underlying problem and the factors related to it. Johnson (1994) summed up the issue by asking "are teachers lacking in mathematics skills, or are they lacking in the ability to conceptualize problems and devise appropriate solution strategies" (p. 89)?

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