STATISTICAL PROCEDURES EMPLOYED IN THE JOURNAL OF AGRICULTURAL EDUCATION

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University faculty, including agricultural educators, must increasingly demonstrate their scholarship through papers presented at research conferences and articles published in refereed journals. In documenting the emphasis being placed upon research and related scholarly activities, Warmbrod (1987, p. 2) asked in his Central Region Agricultural Education Research Conference keynote address:

> What agricultural education researcher -- whether graduate student, beginning assistant professor or tenured professor -- would dare submit a research article or paper to The Journal of the AATEA, to this research conference, or to the National Agricultural Education Research Meeting that ignored technical considerations such as internal and external validity, validity and reliability of instruments, nonresponse and the assumptions and appropriateness of statistical analysis procedures?

To help meet these challenges, Warmbrod (1987) indicated that graduate programs which prepare future agricultural education faculty are devoting more attention to research methodology, data analysis, and the reporting of research. In addition, during the 1980s Ohio State University faculty conducted presessions before the National Agricultural Education Research Meeting (NAERM) and the National Symposium on Research in Extension Education on topics such as designing, conducting, and analyzing research.

Other indicators document the emphasis being placed on the dissemination of new knowledge. The Proceedings of the 1989 NAERM constituted volume 16 for this conference. Each region of the American Association of Teacher Educators in Agriculture (AATEA) conducts an annual refereed research conference. In 1989, the 4th Biennial National Symposium on Research in Extension Education was conducted. The Association for International Agricultural and Extension Education held its 5th annual research conference in 1989. Between 1960 and 1988, The Journal of the AATEA, was an outlet for disseminating agricultural education research before it was renamed the Journal of Agricultural Education.

As the number of outlets for disseminating agricultural education research started to increase, a few scholars began to examine quality dimensions of the research. During his address at the 1988 NAERM, Crunkilton concluded that a considerable amount of the research is conducted by graduate students. Mannebach, McKenna, and Pfau (1984) reached a similar conclusion after analyzing abstracts reported in the 1974-82 Summaries of Research and Development Activities in Agricultural Education. In addition, they found that almost 90% of the research was classified as descriptive. From an analysis perspective, they found that, "About one-third of the studies submitted for inclusion in the Summaries reported the statistical test or technique used" (Mannebach, McKenna, & Pfau, 1984, p. 14).

When researchers perform critical analyses of outlets used to disseminate educational research, most focus on one aspect of the research process. For example, Shaver and Norton (1980) studied replication and randomness as related to the American Educational Research Journal. Several researchers have identified statistical procedures used in reporting educational research (Goodwin & Goodwin, 1985a, 1985b; Elmore & Woehlke, 1988a, 1988b; Willson, 1980).

Other researchers have classified statistical procedures used in educational research as basic, intermediate, or advanced. Goodwin and Goodwin (1985b) found that almost one-third of the procedures used in the American Educational Research Journal (AERJ) and the Journal of Educational Psychology (JEP) were classified as basic. Kelly, Sproles, Camp, Hauser, and Kopf (1989) found that slightly over 60% of the statistical procedures reported in the Journal of Vocational and Technical Education (JVTE), a philosophical and theoretical-based journal, were classified as basic level. Goodwin and Goodwin (1985b) found that almost 45% of procedures used in the JEP and 37% in the AERJ were classified as intermediate. Kelly et al. found that even though less than 10% of the statistical procedures in the JVTE were classified as intermediate, JVTE,

articles contained a high percentage of advanced level procedures (23%). The AERJ and the JEP articles contained 17% and 11%, respectively, of advanced level procedures. The percentage of procedures classified as other or nonparametric ranged from 7-12% for the three journals (Goodwin & Goodwin, 1985b; Kelly et al., 1989).

The Study

Even though the number of outlets for disseminating agricultural education research has increased since the 1970s, critical analyses of the quality of that research are not readily available. In fact, Mannebach, McKenna, and Pfau (1984) found what they described as a "dearth of research on agricultural education research" (p. 15). These researchers recommended that, "If research and development are to lead the way, we must continually review and evaluate our efforts" (Mannebach, McKenna, & Pfau, 1984, p. 15).

Most analyses of agricultural education research that have been conducted thus far have tended to be global in their approach and devoid of the desired depth and precision. For example, in the Mannebach, McKenna, and Pfau (1984) analysis, research abstracts were the primary data sources. The use of such sources is justifiable if cursory perspectives of the research are desired. Prudent researchers, however, will question whether depth can be gleaned from such sources. An analysis can have breadth and depth, however, as was the case when Kelly, Sproles, Camp, Hauser, and Kopf (1989) analyzed a journal that contained only three volumes and 31 articles.

Even though 29 volumes of The Journal of the AATEA were published, few researchers have attempted to compare the quality of agricultural education research with that of related disciplines. In addition, no comprehensive analysis has been performed to identify the statistical procedures used in analyzing agricultural education research. Further, questions related to the levels of statistical procedures used in analyzing agricultural education research have not been examined. Thus, this study was designed to focus on one aspect of the research process, i.e., the data analysis dimension of problems that agricultural educators have investigated. The problem that was examined in the study is captured by the following question: What trends are evident in terms of the statistical procedures that were used in reporting research in 29 volumes of The Journal of the AATEA?

Research Questions

Three questions guided this investigation into trends that emerged in terms of the statistical procedures that agricultural educators used when publishing research in 29 volumes of The Journal of the AATEA:

1. What trends are evident in terms of which statistical procedures were used in publishing research in The Journal of the AATEA?
2. What trends emerged in terms of basic, intermediate, and advanced level statistical procedures being used in research published in The Journal of the AATEA?
3. To what extent are selected variables related to which statistical procedures were used in reporting research in 29 volumes of The Journal of the AATEA?

Methods and Pmcedures

The study was designed to analyze statistical procedures that agricultural educators used when reporting research in 29 volumes of The Journal of the AATEA. The researchers chose nine volumes (three from each decade) for detailed examination. After randomly selecting the 1963 volume from the decade of the 1960s, the researchers chose every third subsequent volume to be analyzed (see Table 1 for specific years). Before starting the analysis, the researchers deemed it inappropriate to analyze articles not classified as either qualitative *or* quantitative research. Articles not analyzed included Debate the Issues, AATEA Distinguished Lectures, and philosophical articles. In addition, as suggested by researchers who have performed similar analyses, only primary statistical procedures used to test research hypotheses or to answer research objectives were coded (P.L. Woehlke, personal communication, July 26, 1989). For example, when an objective indicated that multiple regression was the primary analysis procedure and an author presented a correlation matrix in addition to the regression analysis, only the regression was coded as an analysis procedure.

The framework for the coding was developed by Elmore and Woehlke (1988b). In addition, because of the common practice of including validity and reliability when doing this type of an analysis (see Goodwin & Goodwin, 1985a; Goodwin & Goodwin, 1985b; and Kelly, Sproles, Camp, Hauser, & Kopf, 1989), these categories were included in this investigation analysis (see Table 1). Validity was coded if the authors described procedures used to ensure valid instrumentation. Reliability was coded when the authors reported a reliability coefficient in the article.

In the first stage of the analysis, one researcher read all nine volumes and categorized the statistical procedures. In stage two, second opinions about the procedures were provided by one of the other three researchers. Each of these individuals coded the statistical procedures used in three volumes: one each from the 1960s, the 1970s, and the 1980s. Inter-rater reliability estimates were calculated to check the agreement between the first and second stage coding, i.e., the first researcher and each of the other three researchers. The researchers determined a priori that an inter-rater reliability coefficient of at least .70 (Tuckman, 1988) was the minimum acceptable agreement between two raters. The Goodwin and Goodwin (1985b) formula was used to estimate inter-rater reliability:

$$\text{Inter-rater Reliability} = \frac{\#\text{ of Coding Agreements}}{\#\text{ of Coding Agreements} + \#\text{ of Coding Disagreements}}$$

To ensure agreement between first and second stage coding, one volume was coded and then the inter-rater reliability checked. All coefficients exceeded the minimum standard of .70. Once the coefficients were computed, the coders discussed the disagreements and why they occurred. In instances where the first and second raters could not agree on how to code a particular procedure, the senior author made the final determination. Using these procedures, the estimated agreement between the three pairs of raters (the primary rater and three second opinions) ranged from .81 to .86.

Findings and Discussion

The nine volumes included in the analysis contained 179 articles. Of this number, 119 articles were classified as research-based (quantitative or qualitative). There were 323 statistical procedures employed to treat the data included in the research-based articles. The data presented in Table 1 suggest four trends. First, the number of articles published increased as the number of issues per volume and the number of pages per issue increased. These increases were most pronounced during the 1980s and more than offset a four page increase in the maximum number of pages allowed for manuscripts (from 8 to 12 pages). Second. more research-based and fewer philosophical articles were published as The Journal of the AATEA became older (11 of 44 research-based articles in 1960s versus 27 of 43 during 1970s, and 81 of 92 in the 1980s). Third. two patterns emerged since 1975 regarding the statist&l procedures that authors used in reporting their research. There was an increase in (a) the number of procedures used per article and (b) the variety of procedures employed. In the pre-1975 period, descriptive statistics, bivariate correlational techniques, and nonparametric tests were the predominant procedures used. These procedures continued to be used in the post-1975 period, but other procedures such as the t-test, analysis of variance, and multiple regression were also being used to analyze agricultural education research.

Finally, 98 of the 323 procedures were classified as descriptive. Data presented in Table 1 indicate that over the years there was a decline in the number of descriptive procedures used as a function of the total number of procedures. An examination of Table 1 reveals that agricultural educators did not necessarily reduce their use of descriptive procedures as much as they began using more procedures. Perhaps one explanation for this trend are readily available computer packages such as SPSS (Nie, et al., 1975) and SAS (Helwig, 1978) which compute procedures such as factor analysis, multiple regression, and analysis of covariance.

An inspection of Table 1 reveals that in 1978 authors began emphasizing the validity and reliability of their research. Content and face validity were most often assured by panels of experts. Cronbach's alpha was the predominant procedure used to estimate reliability because most of the dependent variables measured constructs in the affective domain.

To answer research question 2, the procedures presented in Table 1 were categorized using the Goodwin and Goodwin (1985b) framework (see Figure 1). As shown in Table 2, slightly over two-thirds of the procedures used in reporting research in The Journal of the AATEA were categorized as basic and almost 15% as intermediate level. Nonparametric and other procedures comprised the next largest category (13%). Advanced level procedures were used least (5%).

Table 1
Statistical Procedures Used in the Journal of the American Association of Teacher Educators in Agriculture during Selected Years*

Procedure	Years Coded									Total
	63	66	69	72	75	78	81	84	87	
ANOVA/ANCOVA	1			1	2	6	5	9	9	
Bivariate Correlation			1	1		3	4	10	4	23
Descriptive	3	1	4	5	6	9	19	20	31	98
Factor/Cluster Analysis					1	1		2	2	6
LISREL										0
Meta Analysis										0
Modeling			1			1				2
Multiple Regression			1			1	1	5	4	12
Multivariate						1		5	1	7
Nonparametric	1		1	1	3	4	1	4	9	24
Psychometric Theory						2				2
Qualitative					1	1	1			3
Simulation										0
i-test		1			1	3	3	8	12	28
Reliability						4	4	12	22	42
Validity	1					4	3	16	19	43
Tot. Procedures	6	2	8	8	14	40	41	91	113	323
Tot. Articles Coded	4	1	6	8	6	13	20	30	31	119
Tot. Articles Published	15	14	15	12	12	19	25	33	34	179

* Procedure categories from Elmore & Woehlke, 1988b.

Figure 1
Framework Used to Categorize Statistical Procedures as Basis, Intermediate, or Advanced*

Category	Procedure
Basic	Descriptive statistics such frequencies, percentages, central tendency, and variability; Pearson correlation, chi square, t-test, and one-way ANOVA
Intermediate	Factorial ANOVA, planned orthogonal comparisons, post hoc multiple comparisons, trend analysis, one-way ANCOVA, factorial ANCOVA part/partial regression, multiple regression
Advanced	Discriminant analysis, path analysis, canonical correlation, factor analysis, cluster analysis, one-way MANOVA/MANCOVA, meta analysis, factorial MANOVA/MANCOVA
Other Correlational/ nonparametric	Procedures not included in prior categories

* -Categories develop by Goodwin & Goodwin (198Sb).

Pearson correlation coefficients were computed to identify variables related to trends in the use of statistical procedures. High positive relationships were detected among all variables included on the correlation matrix (see Table 3). Recent volumes tended to include more articles, procedures of all levels, and estimates of reliability and validity. In addition, very high interrelationships suggest that procedures of all levels were used in reporting research in The Journal of the AATEA.

Table 2
Levels of Statistical Procedures Used in the Journal of the American Association of Teacher Educators in Agriculture During Selected Years

Year	Number of Statistical Procedures Used by Level				Total	# Articles
	Basic	Intermediate	Advanced	Nonpar/Other		
1963	3	1	0	1	5 (2.1%)	4 (3.4%)
1966	2	0	0	0	2 (.8%)	1 (.8%)
1969	5	1	0	2	8 (3.4%)	6 (5.0%)
1972	7	0	0	1	8 (3.4%)	8 (6.7%)
1975	7	2	1	4	14 (5.9%)	6 (5.0%)
1978	18	4	2	8	32 (13.5%)	13 (10.9%)
1981	27	5	0	2	34 (14.3%)	20 (16.9%)
1984	39	13	7	4	63 (26.4%)	30 (25.2%)
1987	51	9	3	9	72 (30.2%)	31 (26.1%)
TOTAL	159 (66.8%)	35 (14.7%)	13 (5.5%)	31 (13%)	238 (100%)	119 (100%)

Table 3
Intercorrelations Among Year, Number of Articles Published, and Selected Categories of Statistical Procedures Used in The Journal of the American Association of Teacher Educators in Agriculture

	YR	AR	BP	IP	AP	NP	RE	VA
Year Coded (YR)	--	.92	.93	.78	.68	.77	.82	.80
Articles Published (AR)		--	.99	.82	.77	.76	.90	.93
Basic Procedures (BP)			--	.76	.73	.82	.95	.94
Intermediate Procedures (IP)				--	.96	.57	.72	.86
Advanced Procedures (AP)					--	.60	.68	.83
Nonparametric (NP)						--	.91	.85
Reliability (RE)							--	.97
Validity (VA)								--

Implications and Questions to Consider

Statistical procedures used most often in The Journal of the AATEA suggest two trends. Almost without exception, the first objective of articles included in this analysis was to describe the subjects included in the research. Second, the level of statistical procedures used prior to 1975 suggests that agricultural educators asked mostly exploratory level questions which warranted description of phenomena. The widespread use of basic level statistical procedures (univariate and bivariate) suggests that agricultural educators were perhaps not asking research questions which involved prediction, explanation, and cause and effect. The 1980s data, however, suggest that agricultural educators began to expand the scope of descriptive survey type studies that predominated during the 1960s and 1970s. The use of intermediate and advanced level statistical procedures suggests that more questions were asked which involved explanation and prediction.

The findings of this study prompt several questions that should be addressed by the profession. The following individuals are in positions to provide the leadership needed to address the questions: the Journal of Agricultural Education's Editing-Managing and Editorial Review boards, professionals who serve as referees, and faculty who submit manuscripts for publication and mentor graduate students who become members of the profession:

1. To what extent do agricultural educators select research problems that require statistical procedures for explanation and/or prediction rather than description of phenomena?

2. To what extent do agricultural education faculty possess the expertise needed to use statistical procedures, especially those classified as intermediate and advanced?

3. To what extent are agricultural education graduate students being prepared to interpret and use statistical procedures, especially intermediate and advanced level procedures?

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