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Mark A. Balschweid
University of Nebraska - Lincoln, mbalschweid2@unl.edu

Gregory W. Thompson
Oregon State University

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AGRICULTURE AND SCIENCE INTEGRATION: A PRE-SERVICE PRESCRIPTION FOR CONTEXTUAL LEARNING

Mark A. Balschweid, Asst. Professor
Purdue University

Gregory W. Thompson, Asst. Professor, R. Lee Cole, Professor
Oregon State University

Abstract

The purpose of the study was to determine if the delivery of an integrated agriculture and science curriculum to Agricultural Education MAT (Master of Arts in Teaching) pre-service teachers increased their desire and ability to integrate their own curriculum and collaborate with other teachers once they started teaching, and to identify social and cultural barriers in existence between secondary teachers in agriculture and science. The population for the treatment group consisted of all graduate students enrolled in the 1996-97 MAT Agricultural Education cohort at a west coast university. The control group consisted of the previous five Agricultural Education cohorts at the same school. The research combined a series of personal interviews with the treatment group in addition to the written questionnaire administered to the treatment and control groups. The questionnaire served as the comparison for the groups. Data were analyzed using descriptive statistics. Evidence indicated that the treatment group was positive about integrating science into the agriculture curriculum and they were more willing to attend workshops about the integration of science than were members of the control group. Furthermore, the treatment group felt that preparation time was the greatest barrier in working with the science teacher in their school.

Introduction

The concept of integrating science into agricultural education programs has been supported from various sources for over a decade (A Nation at Risk, 1983; Understanding Agriculture: New Directions for Education, 1988; Secretary's Commission on Achieving Necessary Skills, 1991). Most recently, the United States Department of Agriculture funded a competitive grants program designed to strengthen agricultural education with the specific intent to prepare more students to pursue careers in agriscience and agribusiness by incorporating agriscience into science, business, and consumer education programs (U. S. Department of Agriculture, 1999).

The call for integration of academic and applied concepts can be heard from both academic and vocational sources. The American Association for the Advancement of Sciences has recommended connecting what students learn in school through interdisciplinary links, real-world connections, and connections to the world of work (Project 2061, 1993). The focus of many current science education initiatives has focused around learning in context. Programs such as Project WILD, Project WET, and Project Learning Tree have contextual learning as their theoretical underpinnings. All of these programs serve as a method of combining the natural sciences, mathematics, and technology with the social and behavioral sciences into a coherent whole. It is difficult to discuss living organisms, plants, and animals, devoid of any conversation involving science. The integration of academic principles into agriculture and natural resources can provide the context necessary for students in the 21st century to understand the world they live in.

The theoretical/conceptual model that supports the integration of science with applied sciences is found in brain-based theory. Caine and Caine (1994) summarize that various disciplines relate to each other and share common information that the brain can recognize and organize. The authors add "the part is always embedded in a whole, the fact is always embedded in multiple contexts, and a subject is always related to many other issues and subjects" (p. 7). Furthermore, research findings support the claim that the integration of science into the agriculture curricula is a more effective way to teach science. Students taught by integrating agriculture and scientific principles demonstrated higher achievement than did students taught by traditional approaches (Enderlin & Osborne, 1992; Enderlin, Petrea & Osborne, 1993; Roegge & Russell, 1990; and Whent & Leising, 1988).

The integration of disciplines offers unique opportunities for faculty to network. It can provide a vehicle for professional development efforts to unite and educate teachers of science, mathematics, reading, and writing, and natural resources/agriculture to establish and improve rapport. It allows for teachers to address the diversity of learning styles through the application of experiential learning. And, it urges teachers to recognize community and accept the responsibility to collaborate with other members of that community in highly functioning relationships. But where do teachers learn the techniques for integrating their curriculum and collaborating with other teachers?

Teacher preparation of academic and applied science teachers should focus on embedding the content within the context and presenting it in such a way that students find difficult to separate. The preparation of these teachers should focus on looking beyond the barriers that exist between academic and vocational knowledge, understanding, and skills.

In a national study, Thompson (1996) found Agriscience teachers perceived that undergraduates would be better prepared to teach if they received instruction on how to integrate science and if they student taught with a cooperating teacher who integrated science. Thompson also concluded that agriscience teachers believed teacher preparation programs should provide in-service training for teachers on how to integrate science and recommended that in-service programs be offered to assist teachers in integrating science into the agricultural education curriculum. But is in-service training enough? Should pre-service teacher education focus on the issues of integration and collaboration between sciences and applied sciences?

Objectives

The purpose of the study was to determine the impact of delivering an integrated science/agriculture curriculum upon agricultural education teachers at the pre-service level. The specific objectives of the study were to:

1. describe the effects of the integrated agriculture and science curriculum upon pre-service agricultural education teachers' *desire* and *ability* to integrate their own curriculum and collaborate with other teachers once they started teaching;

2. determine barriers that beginning agricultural education teachers perceived which could inhibit them from collaborating with science teachers.

Procedures

The design of the study was pre-experimental, static-group comparison (Gall, Borg and Gall, 1996, p. 507). Since a random sample of students was not studied, the findings of this study should not be generalized beyond the population used. The research study used a combination of

qualitative and quantitative analysis in order to utilize the strengths of each research methodology (Reichardt and Rallis, 1994). Specifically, the research combined a series of personal interviews with the treatment group in addition to the written questionnaire administered to both the treatment and control groups. The treatment was administered in three phases during the 1996-97 academic year. Observations were timed to occur either during or after each phase of the treatment. During the 1996 fall term students were enrolled in a micro-teaching class. Students viewed sample agriculture lessons that included scientific principles, and were taught methods of integrating scientific principles into their own lessons. Then, the students themselves developed and delivered lessons that contained scientific principles within the agricultural context. Finally, students viewed the lessons of their cohort members that integrated science and had the opportunity to evaluate those lessons for content, delivery and methodology. Interview #1 took place during the 1996 fall term.

During the 1997 winter term, the teacher preparation cohort members were teaching at their student teaching sites. The student teachers were required to deliver a science-based lesson to an AST (Agricultural Science and Technology) class. In addition, they were required to establish contact with a science teacher in their building and observe that teacher in the classroom setting. Finally, the student teachers were required to borrow equipment and/or supplies from the science department for use in the agricultural classroom. Interview #2 occurred during the 1997 winter term. The purpose for observing and interacting with a science teacher was to establish a connection that would help to identify the level of collaboration and the existence of cultural and/or social barriers that might surface once the pre-service teacher began integrating scientific principles into the agriculture curricula as a practicing teacher.

During the 1997 spring term, members of the 1996-97 teacher preparation cohort were required to attend a one-week job shadowing/team-teaching experience at an urban middle school. The teachers selected for observation and interaction were science teachers. Interview #3 occurred during spring term of 1997 following the middle school experience. The purpose for this phase of the treatment was to allow pre-service teachers the opportunity to observe science teachers to experience current methods of teaching science and to observe the personality and teaching styles of science teachers.

The population for the treatment group, and the qualitative portion of the study, consisted of six graduate students enrolled in the 1996-97 MAT (Master of Arts in Teaching) agricultural education cohort at a west coast university. Due to the size of the population, all members of the cohort were included in the study. The subjects representing the control group, and involved in the quantitative analysis of the study, were members of the previous five MAT agricultural education cohorts at the same institution. Beginning in 1991-92 with the first cohort and continuing through 1995-96, thirty-three students completed the Agricultural Education MAT program and became eligible for teaching employment. Fifteen members from this group became practicing teachers. Due to the size of the population, all fifteen members were included in the quantitative analysis of the study. Members of the control group received training consistent with agricultural education teacher preparation methods used prior to any emphasis on the integration of academics into the agricultural education curriculum. In addition, no focus on teacher collaboration was given during the control group's pre-service teacher preparation.

The final data collection occurred in December of 1997 with a mailed questionnaire. The survey was sent to all members of the six agricultural education teacher preparation cohorts from 199l-97 who were teaching agricultural

education. The questionnaire consisted of three sections. Section one contained eight statements concerning the integration of science into the agriculture curriculum. Teachers were asked to rate each statement concerning curriculum integration using an ordinal scale regarding the *importance* they placed upon the statement. A similar scale was used to determine their level of *involvement* with the contents of the statement. Section two contained twelve statements concerning potential barriers that could exist between science and agriculture teachers.

The instrument used in the study was submitted to a panel of experts consisting of agriculture teachers and university professors who reviewed it for content validity. Refinements were made in the draft instrument consistent with panel input to improve content validity. The instrument was pilot tested in October of 1997 by eight beginning Agricultural Science and Technology teachers who were not part of the study. Cronbach's coefficient alpha was used to calculate the internal consistency of the instrument. Reliability for the ordinal and Likert-type sections of the instrument was calculated from the field test at α=0.867 and post hoc for the control and treatment groups at α=0.852. The survey instrument and cover letter were mailed to fifteen teachers in the control group and four teachers in the treatment group for a total of nineteen teachers. Two of the original six members of the treatment group did not enter the teaching profession as a secondary agricultural education instructor and were eliminated from the survey portion of the research.

All subjects returned the survey for a 100 percent response rate. Frequency counts, percentages, means and standard deviations were used for analyzing the data. No predictive statistics were used for this study since the survey groups involved were the population.

Qualitative Findings

Two types of results were gathered during this study: qualitative and quantitative. The qualitative data yielded findings from interviews conducted only with the treatment group. Although the results from the interview series were used to guide the development of the questionnaire used in the quantitative portion of this study, the responses to the interviews also yielded useful data pertinent to this study.

When the respondents in the treatment group were initially asked to estimate their perception of how much science should be integrated into the agriculture curriculum, the mean response for percentage of science they would include was 74%. When asked the same question three months later, after they had been involved in student teaching at their assigned school, the mean response was 54%. Reasons given for the decrease in the perceived amount of science integrated into the agriculture curriculum included the amount of time needed by the AST teachers to incorporate science and the desire to be sure they could teach the scientific principles accurately. Further comments included:

> *The only thing is that hands on experiments take time. There is a lot of things that I realize you just have to plow straight through and give them other information. If I'm going to be truthful I'm going to say science has to be about twenty percent if you're going to include everything else. (F1)*

Respondents in the treatment group were asked for their perceptions concerning how receptive they thought the science teachers at their school were regarding their attempts to infuse science into the agriculture curriculum. Three out of the four (75%) respondents indicated a favorable impression of the science teacher in

response to their efforts to integrate scientific principles into the agriculture curriculum. The subjects in the treatment group were asked if it was important for them to "like" the science teacher in their respective schools. Every respondent in the group indicated that it was important. Comments included:

> *I think that it's absolutely essential. Because if you can 't work with them, and for instance you want to have science credit in your classroom, they'11 never allow it. (F3)*

> *It's hard. I know since this is confidential I can say this: if I had to work with at least one of the people here, specifically, I don't think I could do it. I really don't. Just because of the differences. (MI)*

Interview #3 occurred after the conclusion of the treatment phase of the study. The treatment group was asked if they felt confident in their ability to integrate scientific principles into their agriculture curriculum and to collaborate with the science teacher when they arrived at the school where they were hired. Four out of five (80%) responded with words such as "definitely" and "confident" that they could accomplish this task. Finally, the subjects in the treatment group were asked how long they felt it would take before they would be willing to integrate science and to think about ways to collaborate with science teachers at the schools where they were hired. Three out of five (60%) responded it would be at least three years. One (20%) subject responded with "at least the second, if not the third year." Further comments included:

> *It's going to take three to five years to feel comfortable with what I'm doing so that I can feel comfortable enough to step out of my comfort zone and work with other teachers. I'll continue anything that the department has going, but beyond that I wouldn't want to start anything new. (FI)*

> *I don't know if you could ever integrate everything, You could be working on it for years. I don't really think it's a final place you reach; I think it's a never-ending pursuit. But I think after about three years you should have a basic element in every area you want to implement it in. (F2)*

Quantitative Findings

In addition to collecting information regarding teachers' desire and ability to integrate science into the agriculture curriculum the questionnaire sought to collect demographic information. Table one presents selected demographic characteristics of the treatment and control groups.

Question numbers one through eight of the questionnaire dealt with the *need* felt by secondary agricultural education teachers for incorporating scientific principles into the Agricultural Education Program through collaboration and integration efforts. For these questions, a five-point ordinal scale was used to assess the importance respondents placed on each statement. The choices for selection of importance were l=Unimportant, 2=Below Average, 3=Average, 4=Above Average, and 5=Utmost. The raw mean scores on the eight statements were the lowest, 3.33 and 3.25 for the control and treatment groups respectively, for the statement "my AST curriculum should be reviewed by the science teacher(s) to ensure scientific principles are being taught accurately".

Table 1. Descriptive Statistics for Selected Demographic Characteristics of Treatment and Control Groups (N=19)

Characteristic	Treatment			Control		
	N	Mean	SD	n	Mean	SD
Age	4	27.5	2.6	15	29.1	4.8
Years of Teaching Experience	4	1.0	0.0	15	3.0	1.2
Number of Students in your school	4	1500	424.2	14	783	448.0
Number of Faculty in your school	4	93.2	58.7	12	47.8	42.1
Does your school give science credit for Agricultural Science and Technology courses?	4	3	1	15	8	7
Have you ever attended any workshops on agriscience?	4	4	0	15	14	1
Do you share a common prep period with any of the science teachers in your school?	4	2	-	15	9	5

The two questions which received the highest marks were "science teachers should be aware of the efforts to integrate science into AST programs within their building" (4.53 for the control group, 4.75 for the treatment group), and "AST instructors should attend workshops on incorporating scientific principles into their curriculum" (4.27 for the control group, 5.00 for the treatment group).

Question numbers one through eight of the questionnaire also asked for the respondents to rate their *involvement* in the statements listed concerning the concept of incorporating scientific principles into the Agricultural Science and Technology Program through collaboration and integration efforts. For questions one through eight, a five-point ordinal scale was used to measure the degree of involvement of the respondents with regard to each collaboration and integration statement. The choices for selection of involvement were 1=Never, 2=Seldom, 3=Sometimes, 4= Much of the time, and 5=Always. Teachers in the control group rated the statement, "AST teachers should integrate scientific principles into their lessons", higher than the other statements with a 4.00 indicating they were involved in it "much of the time". Meanwhile, the teachers in the treatment group rated their involvement with the statement, "science teachers should be aware of the efforts to integrate science into the AST programs within their building", higher than the other statements giving it a rating of 4.00. The lowest rated statement by both the treatment and control groups was "my AST curriculum should be reviewed by the science teacher(s) to ensure scientific principles are being taught accurately". This statement received a score of 1.75 from the treatment group and 2.13 fi-om the control group indicating they were seldom involved with this activity.

The survey included twelve questions which asked the respondents to rate their perceptions of the existence of social and/or cultural barriers which could inhibit their ability to collaborate with the science teacher(s) in their school and limit their ability to integrate science into their agriculture curriculum. The twelve

questions asked respondents to make selections using a five-point Likert-type scale to indicate their perceptions of each statement. Respondents' choices were 5=strongly agree, 4=agree, 3=neutral, 2=disagree, l=strongly disagree, and N/A=not applicable. Of the twelve statements listed "time is a barrier in working with the science teacher(s) at my school" received the highest mean with both the control and treatment groups scoring the statement greater than 4.00 indicating their agreement with the statement. The statement receiving the second highest score was "a lack of understanding about agricultural science among the science teacher(s) is a barrier to working with the teacher(s) at my school" with control group teachers rating the statement 3.79 and treatment group teachers rating it 3.75.

Three open-ended questions asked respondents to provide information in detail regarding barriers that prohibit them from collaborating with the science teacher(s) in their building. When asked, "what do you feel is the greatest barrier to working with the science teacher(s) at your school?" three out of four respondents in the treatment group mentioned the time required. Five of the fifteen teachers in the control group responded to the same question by writing that time was the greatest barrier inhibiting them from collaborating with the science teacher in their school.

Respondents were asked to list any other differences they perceived as barriers that prevented them, or could prevent them, from working with the science teachers in their schools. The responses to this question were broader in range. Two out of the eight responses (25%) from the control group indicated that competition for the same students caused a barrier between the science teacher and the agriculture teacher when trying to collaborate and integrate scientific principles into the agriculture curriculum. One of the three responses (33%) to this question from the treatment group also stated competition for students as their answer.

Conclusions

The conclusions of this study were based on the responses of the agricultural education teacher preparation cohorts from 1991-97 currently teaching secondary agricultural education. Although other teacher training programs emphasize the integration of science into the agriculture curriculum, caution must be exercised when generalizing the results beyond the population of this study.

When the respondents in the treatment group were initially asked to estimate their perception of how much science should be integrated into the agriculture curriculum, the mean response for percentage of science they would include was 74%. When asked the same question three months later, after they had been involved in student teaching at their assigned school, the mean response was 54%. Reasons given for the decrease in the perceived amount of science integrated into the agriculture curriculum included the amount of time needed by the AST teachers to incorporate science and the desire to be sure they could teach the scientific principles accurately. Integration was perceived as important by the subjects but the drop in favoring integration reflects the reality of the time commitment required to integrate scientific principles into the agriculture curricula.

When asked how important a common teaching style was to the success of collaboration efforts between agriculture and science teachers all five (100%) treatment group teachers responded that it was not important to the success of the collaboration effort. Since all five also indicated it was important to "like" the science teacher in their building in order to work with him or her it appears that beginning teachers perceive a common personality as more important to successful collaboration with science teachers than

a common teaching style.

Treatment group cohort members who received pre-service instruction on integrating science into the agriculture curriculum and in methods of collaboration with science teachers were confident of their ability to accomplish these tasks after becoming licensed teachers. However, at the conclusion of their student teaching experience, all treatment group teachers expressed concern that it would take at least one year, and most likely three years, before they could implement many of the integration and collaboration practices. Given the schedule of teachers and the expectations placed upon them, integration will take time to emerge as a priority.

In the open-ended questions concerning barriers to collaboration teachers in both groups indicated that the past history of the agricultural education program influenced the perceptions of the science teachers in their building towards the agricultural education program. This is in agreement with the conclusions of Osborne and Dyer (1995). Since many agricultural education programs face poor images due to past history, agriculture teachers could improve the reputation of the program by allowing science teachers to assist them in developing segments of the agriculture curriculum to capitalize on opportunities to repair severed ties and establish improved reputations.

Respondents in both the treatment and control groups rated time as the greatest barrier to integrating science into the agriculture curriculum and to collaborating with the science teacher on methods of integration. There is evidence that agriculture teachers need more preparation time for integrating science concepts into their curriculum and for collaborating with the science teacher in their school, This was the only barrier to receive a mean score greater than 4.00. This concurs with the findings of Thompson (1996).

When asked for additional barriers to collaboration, respondents from both groups indicated competition for the same students was a barrier perceived by beginning agriculture teachers. The need for the same equipment at the same time the science teacher was using it was also a barrier inhibiting agriculture teachers from borrowing materials, equipment and supplies from the science department. Clearly, if communication between the science and agriculture teachers were increased concerning the coordination and timing of curricula taught within the year, the necessary supplies, materials, and equipment could be available when each of the teachers involved was ready to use them.

Recommendations

Agricultural education teacher preparation graduates should be encouraged to participate in activities at their building sites which would foster relationships with members of the science department and general faculty to increase the opportunities for collaborative endeavors and for overall marketing of the secondary agricultural education program. Priority should be placed on communication and public relations strategies for teacher preparation graduates in agricultural education to educate the faculty at their school, especially the science teachers, on the mission and focus of the local Agricultural Education Program.

Since many secondary agricultural education teachers have extended summer contracts, district administrators should offer science teachers extended contract days for the purpose of allowing collaborative efforts between the agriculture and science teacher to take place without the time constraints and distractions that occur during the academic year.

The approach to teaching undergraduates in education should focus on joint methods courses that model and emphasize collaborative relationships. Courses should foster opportunities

for interdisciplinary teaching and learning that will create linkages for future endeavors. Cross-curricular opportunities should provide mechanisms for establishing relationships with teachers regardless of where the individual graduate begins teaching.

Since all beginning teachers in the treatment group indicated it would take at least one year and most likely three years before they could implement integration and collaboration strategies, it is recommended that a follow-up study with the same population be conducted after they have completed three years of teaching to determine the level of science integration and science teacher collaboration.

The Agricultural Education Department at the university studied should consider offering joint in-service workshops for agriculture teachers and their district's science teachers for increasing integration and collaboration.

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