

## THE USE AND DESIGN OF LABORATORY INSTRUCTION IN SECONDARY AGRISCIENCE CLASSROOMS

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### Abstract

*The purpose of this qualitative study was to examine the use of laboratory instruction in agricultural education classrooms. Interviews were conducted with four agricultural education teachers to determine the design process and assessment of laboratory activities. Additionally, benefits and challenges to the use of laboratory instruction were identified. The findings suggested that the teachers implemented a variety of laboratory activities. The teachers recognized multiple benefits including the active nature of the activities, an increase in cooperation and motivation among students, and improved subject matter retention. The challenges of laboratory instruction were increased preparation time, large student enrollments, lack of supplies and equipment, and inadequate funding. The teachers utilized multiple methods to assist in designing laboratory activities that commonly included written reports, participation grades, and performance evaluation for student assessment.*

## Introduction

In 1988, the National Research Council recommended that all students should have an understanding of basic science concepts. In response to this recommendation, at the National Conference on AgriScience and Emerging Technologies, strategies were identified to incorporate the teaching of science into high school agriculture programs. Also recognized was the need for developed materials to assist in the instruction of agricultural science. Lee (1994) stated that agriscience has expanded its purpose to provide students direct application of science education.

Buriak (1989) defined agriscience as, “Instruction in agriculture emphasizing the principles, concepts and laws of science and their mathematical relationship supporting, describing, and explaining agriculture” (p.18). Within the agriscience curriculum, agriscience laboratory activities are viewed as “learning experiences in which students interact with materials and/or models to observe and understand the nature of agriculture and its underlying biological, physical, and social science components” (Myers, 2005, p.14). These activities allow the learner to construct scientific knowledge, skills, and value from direct experience. This type of instruction is applicable to any agricultural program and allows for practical, guided experience for students to learn and test science concepts.

Dewey (1938) expressed how important experience is in the education process, “What he (the learner) has learned in the way of knowledge and skill in one situation becomes an instrument of understanding and dealing effectively with the situations which follow” (p. 44). Laboratory instruction can offer a way to structure experiential learning within the classroom. One of the principles of experiential education is that students actively engage in their own education and these experiences require personal initiative, enhance decision making, and develop individual accountability (Luckmann, 1996). This type of learning requires the use of basic science process and inquiry skills to solve problems and make decisions. In addition, it presents quality experiences, active engagement, and application of abstract concepts useful for comprehensive understanding.

This “hands-on” approach to teaching has traditionally been an agriculture teacher’s preferred method of teaching (Phipps & Osborne, 1988). However, many believe that agriculture teachers need to become more skilled at teaching students basic science process and inquiry skills through the use of science principles (Enderlin & Osborne, 1992). One method of merging student understanding of science principles with the hands-on style of agricultural education is through the use of laboratory classes and exercises. The amount of time engaged in hands-on active learning activities has been found to be a valid predictor of student science achievement (Phi Delta Kappa International, 2004). The use of laboratory instruction provides students the opportunity to make sense of abstract and complex scientific concepts through meaningful engagement with laboratory materials. This interaction encourages success among a variety of students. Johnson, Wardlow, and Franklin (1997) state, “science education can inform the agricultural education profession as it moves to a more science-based curriculum,

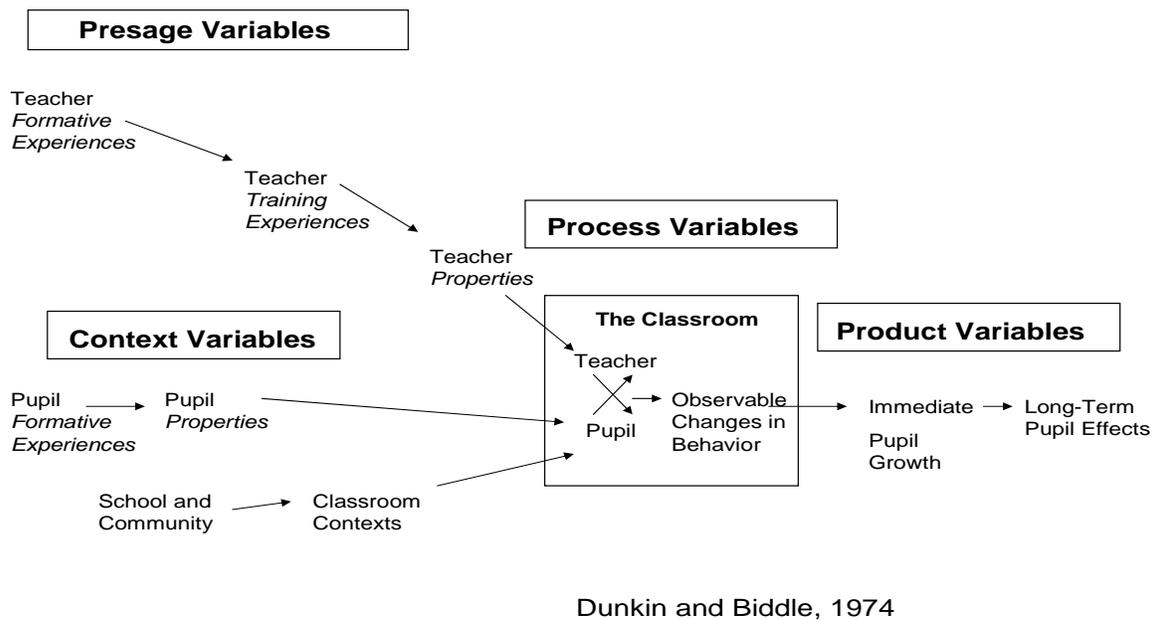
specific research involving agricultural education teachers and students is needed. It is only through such research that the effectiveness of instructional practices in agriscience can be evaluated” (p. 10).

The science education literature is quite clear on the teaching approach that should be employed in teaching scientific concepts in both the laboratory and the classroom. In the *National Science Education Standards* (National Academy of Science, 1996), inquiry based instruction is identified as being the key to improving student understanding of science. It could be reasoned that this teaching approach should also be employed by agriscience instructors attempting to achieve the same purpose. Teachers of agriculture have been found to possess the requisite science process skills necessary to teach integrated science in the agricultural education laboratory (Myers, Washburn, & Dyer, 2004). However, Myers (2004) found that many secondary agricultural education teachers were unfamiliar with the inquiry based instructional strategy. Baker, Lang, and Lawson (2002) note several problems that may arise in a hands-on learning environment such as the agriscience laboratory setting. They recognized the time and energy required for preparation, inadequate facilities, student immaturity, safety concerns, and management of materials and equipment as being major concerns of teachers implementing hands-on activities. According to Horton (1988), overcrowding is the number one safety concern cited by teachers.

The majority of research conducted in this area has examined the attitudes and perceptions of various groups within education and agricultural education regarding the integration of science into the agriculture curriculum (Myers, Washburn, & Dyer, 2004). Although these studies have been important, the time has come to build upon the critical foundation they have laid. This study attempted to look inside the agricultural education classroom/laboratory to examine what is actually occurring based on the perceptions of current agriculture teachers.

### **Theoretical Framework**

A prototypical model of teaching was suggested by Mitzel (1960). He proposed that teaching must take into account sets of variables: teachers and students, their interactions, and the product of those interactions. Dunkin and Biddle (1974) expanded on the Mitzel model to include four major variable types: presage, context, process, and product (see Figure 1). Presage variables, such as teacher formative experiences, teacher-training experiences, and teacher properties, concern the characteristics of teachers that may influence the teaching process. Context variables concern the conditions to which the teachers must adjust, and include characteristics of the environment about which teachers, school administrators, and teacher-educators can do very little. Process variables include the actual activities in which teachers and pupils engage in while classroom teaching is taking place. Product variables focus on the outcomes of teaching, specifically the changes that result in the students.



**Figure 1. Mitzel model of teaching**

This study attempted to identify the various factors that make up these variables in the agriscience education laboratory. By gaining a better understanding of these variables and their interaction, it is hoped that student achievement in science and agriculture can be improved.

### **Problem Statement**

If hands-on learning or a laboratory activity is a preferred and successful method of instruction, and many agriculture teachers are teaching scientific concepts in their courses, the question needs to be asked, “How are agriculture teachers using laboratory activities in their classrooms to promote the learning of agriscience principles?”

### **Purpose and Objectives**

The purpose of this study was to examine the use of laboratory instruction in agricultural education classrooms. The objectives of this study were to:

1. Identify the definition and use of laboratory instruction.
2. Determine benefits and challenges to the use of laboratory instruction in agricultural education classrooms.
3. Explain how laboratory activities are designed for use in the agricultural education program.
4. Describe the assessment techniques used for laboratory activities.

## **Methods and Procedures**

A qualitative approach was utilized to explore the use of laboratory instruction in agriscience classrooms. Interviewing allowed for the researchers to develop an understanding of the environment and use of laboratory instruction techniques in classroom settings (Seidman, 1998). The purposive sample for this study included four agriscience teachers in a southern state. Initially, using the state's agricultural teacher directory, a list was generated of potential teachers to contact regarding participation in the study. After consultation with an agricultural education faculty member from the state's land-grant institution, eight potential teacher participants were identified as having an effective lab component in their agricultural education program. Using electronic mail and the telephone, four randomly selected teachers were contacted prior to the State FFA Convention to solicit their cooperation and participation in the study. Upon agreement to participate, interview times and locations were arranged with the selected teachers.

The final sample was comprised of teachers with a range of teaching experience (1 - 20 years) from different regions around the state. Three of the teachers taught high school and one teacher taught middle school. All of the high schools were rural with a production oriented curriculum. The middle school was located in a suburb of a major metropolitan area in the state. Each of the interview participants had a production agriculture background and earned bachelor degrees in either agricultural education or agricultural science.

## **Method of Data Collection**

Semi-structured interviews were used to collect data for the study. The interview questions encouraged each teacher to identify benefits and challenges associated with the use of laboratory instruction and to describe how they implemented and assessed laboratory activities in the agriscience classroom. An interview guide was used to structure the interview process, but the researchers included probing questions for expansion and clarification of answers. A single interview lasting 20-25 minutes was conducted with each teacher. With the consent of the participants, each interview was audio-taped and transcribed at a later time. When completing the open coding process, a line-by-line method was used to identify common themes in the responses of the participants. To enhance the trustworthiness of the study, analyst triangulation was used (Patton, 1990). This type of triangulation was achieved through the use of two interviewers and the analysis of data and comparison of findings among multiple individuals.

## **Results**

### *Objective One*

Objective one sought to identify the definition and use of laboratory instruction in agricultural education classrooms. Participant definitions of laboratory instruction included hands-on activities and "instruction that consists of students engaged in

investigations where they work in groups, use equipment, and search for solutions to problems outside the realm of a textbook.” Some examples of laboratory activities that the teachers included in the classroom were: livestock reproduction labs, injection labs, insect dissection, palm transfer, agricultural mechanics, land laboratory activities, welding, and germination. All of the teachers stated that they tried to spend approximately 50% of their instructional time engaged in laboratory activities. However, in some courses the amount of time devoted to laboratory instruction was as high as 80%. One teacher stated, “I try to find a happy medium between the two. But, it varies throughout the year.”

### *Objective Two*

Objective two sought to determine benefits and challenges to the use of laboratory instruction in agricultural education classrooms. The most commonly discussed benefit referred to the active nature of laboratory instruction. Additionally, the teachers described the positive aspects of cooperation and socialization among students and an increase in the retention of subject matter when participating in laboratories. The teachers also recognized an increase in student motivation, “they are more motivated to learn because they are having fun while they are doing it” and credited laboratory instruction for improved student recruitment and retention, “they (students) know that they are not going to have to sit behind a desk everyday.”

The integration of laboratory activities was also identified as a recruitment tool. All participants agreed the laboratory nature of their courses attracted students to their programs. The teachers noted that by having quality laboratory activities, students were able to apply the information they gained in the classroom.

All participants identified similar challenges to teaching in the agricultural education laboratory setting. The following items were identified as common challenges to the use of laboratory instruction: extra amount of preparation and planning time required, inability to obtain necessary supplies and equipment, large student enrollment in classes, and lack of funds. One teacher described the challenge posed by sharing equipment with the science department,

as willing as they (the science department) are to share, it becomes a logistical issue of you’ve got to schedule it because that class is using them today and tomorrow and if you do not have it mapped out well when your lesson is weeks in advance then it is a challenge in getting those things when you need them.

With the increased use of laboratory instruction, student safety becomes even more important and challenging for the teacher. Safety concerns recognized by one teacher were, “whenever they are out of their seats the possibility of accidents is much greater like tripping, getting pushed, falling off a chair, breaking a test tube while their glasses are on their foreheads instead of on their eyes.”

### *Objective Three*

Objective three sought to explain how laboratory activities are designed for use in the agricultural education program. The teachers cited the use of previously developed laboratory curriculum, prior experience, common knowledge, and textbooks to assist in the development of laboratory activities. The lack of quality agriscience curriculum, including laboratory activities, was cited as a reason limiting the number of laboratory exercises incorporated into the teachers' courses. They noted that time was a limiting factor on their ability to adapt exercises found on the web or in science textbooks for use in their classes.

The participants' schools did not offer any opportunities for professional development related to laboratory instruction, "the only thing my school promotes at all is reading." The only source of relevant professional development was offered through university sponsored workshops. Also, the teachers received limited instruction on the incorporation of laboratory activities during their preservice teacher preparation. One teacher noted that during her preservice teacher program she had taken one laboratory instruction course.

### *Objective Four*

Objective four sought to describe the assessment techniques used for laboratory activities. According to the National Research Council (2001), assessment includes "making judgments about students' quality of work and designing the necessary steps for improvement" (p.7). The teachers cited the use of written reports, and performance and participation grades as the most frequent methods of assessment. One teacher recommended, "always collect a written product."

Subjective grading was also a common measure of student achievement. As one teacher stated, "It's subjective... Tests don't really tell the true story on several kids... We run a farm basically so it's not new and fun every time we go out", so subjective grading becomes a frequently used assessment technique for laboratory instruction.

## **Conclusions / Recommendations**

All participants tended to define laboratory instruction as any type of hands-on activity. They did provide some clarification in their definition, yet it still failed to fully embrace all aspects of the definitions found in the literature.

Laboratory instruction was reported to provide benefits to the total agricultural education program. Increases in student motivation and achievement were reported by all teachers involved in this study. Teachers also noted a positive relationship between the incorporation of laboratory activities and student recruitment and retention. This concurs with similar findings by Myers, Dyer, and Breja (2003).

The participants in this study confirmed the earlier findings of Baker, Lang, and Lawson (2002). Most lamented the lack of time, equipment, and prepared agriscience laboratory activities as the major challenges they faced in the use of laboratory instruction. It should also be noted that all teachers that were part of this study had a very positive relationship with school administrators and guidance counselors. None felt that they faced the challenge of being a “dumping ground” for difficult students.

A lack of prior preparation and experience may hinder the use of laboratory instruction in the classroom. During preservice preparation, only one of the four teachers received any type of preparation to assist them with the implementation of laboratory activities. With the transition to agriscience, laboratory instruction should be included in the teaching methods course. Not only should preservice students learn about laboratory instruction, but they should be given the opportunity to participate in laboratory activities. Additionally, preservice students could observe current teachers who have effectively implemented laboratory instruction into their program or facilitate a laboratory activity during one of their early field experiences.

The participants identified a lack of local professional development opportunities for laboratory instruction and an absence of necessary supplies and equipment. With the absence of such opportunities, agricultural education departments should design or collaborate with science educators to deliver teacher workshops. The most successful professional development activities are extended over time and actively involve teachers in the learning activities that they will incorporate in their classrooms (National Research Council, 2000). To enhance continuity, faculty members should develop a sequence of professional development workshops to extend over a period of several years. To address the problem of limited supplies, the workshop activities should include laboratory activities that can be completed using inexpensive and easily available supplies. Additionally, teachers should have the opportunity to participate in all the laboratory activities included in the workshops.

Hands-on experience available through laboratory instruction plays a central role in the learning process and educators should place more emphasis on this concept when developing curriculum. Active involvement with individual projects, group activities, and real life situations improves student motivation, behaviors, and understanding of abstract concepts and theories. Teachers should incorporate similar opportunities into their classes that require students to participate in these methods. These experiential activities are positively correlated with student achievement scores, enhancing leadership development skills, and teaching personal responsibilities (Cheek, Arrington, Carter, & Randell, 1990). By employing new strategies and teaching applications, agricultural educators can continually enhance their programs and positively impact student learning and growth.

Furthermore, more quality agriscience laboratory activities should be developed and disseminated to classroom teachers. Those involved in this study made it clear that if more fully developed activities were available, they would utilize those materials. It is

also possible that these materials exist, yet teachers are just unaware of how to access them. Further investigation is needed to address this curriculum availability/access issue.

Additional research is also needed to more completely understand the working definition of laboratory instruction held by current agriscience teachers. Moreover, and possibly more importantly, further investigation is needed to determine the actual amount, types, and quality of laboratory instruction taking place in agricultural education programs. More qualitative investigations should be conducted to gain a better understanding of current practice. Then based upon this foundational knowledge, experimental studies can be conducted to evaluate the effectiveness of various laboratory instruction techniques.

Agriscience offers a meaningful context for the application of science. The teacher is an essential element in this process. In order for successful laboratory instruction to occur within the classroom, the teacher must supervise, direct, and facilitate activities so science process skills and concepts can be developed. With appropriate teacher guidance, students can construct scientific knowledge in the context of agriculture.

As agricultural educators become more accountable for teaching science, they must change their teaching styles and allow students to engage in self discovery learning. Laboratory instruction in the agriculture classroom offers an appropriate, meaningful setting for students to develop these skills. Teachers must take advantage of laboratory activities and challenge students to have a hands-on/minds-on learning experience.

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