

A Cooperative Poultry Research Project to Enhance Critical Thinking, Problem-solving, and Research Skills



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Abstract

Three broiler nutrition research studies were designed and implemented over three semesters to evaluate the influence of student-directed research on enhancing critical thinking and problem-solving abilities in undergraduate students in an animal nutrition and feeding course. Student research teams were randomly assigned to dietary treatments and responsible for animal husbandry, data collection, and statistical analysis. The objective of the project was to determine if early feed restriction of broiler chickens influenced live performance, growth compensation, and carcass yield. Each student research team was required to calculate performance and carcass parameters for statistical analysis and develop a research manuscript. Through completion of the research project, students were required to apply principles of animal feeding to broiler management, analyze the results of the study for determination of pertinent trends, synthesize conclusions from the resulting data, and evaluate the implications of innovative feeding regimes for broiler production. Based on the results of this project, the incorporation of a comprehensive research study into an undergraduate animal sciences course strengthened critical thinking, problem-solving, and team building abilities in students and taught animal research techniques.

Introduction

Development of critical thinking skills is tantamount to the complete undergraduate educational experience and vital for preparing students for career success. For this purpose, college instructors have developed a wide array of innovative instructional techniques, such as cooperative learning team projects, problem-solving exercises, and critical thinking programs, to enhance students' educational

experiences, increase student motivation, and better prepare individuals for successful careers in the agricultural sector (Christy et al., 2000; Kesler, 1998; Miller and Polito, 1999; Murano and Knight, 1999). Among these, endeavors in cooperative learning can be valuable approaches to innovative instruction. Although many educators choose more traditional approaches (e.g., lecture), the benefits of cooperative learning have been clearly established (Bruening, 1990; Caprio, 1993).

Animal agricultural sector employers are committed to hiring graduates with superior communication, leadership, and technical skills (Pardue, 1997). Increasingly, however, animal industries (e.g., poultry industry), due to insufficient numbers of technically trained graduates with strong communication and problem-solving abilities, are hiring candidates with less technical expertise, but possessing intangible employable skills (i.e., interpersonal communication, problem solving, critical thinking, and team work competencies). In a recent review, the poultry industry reported an estimated annual shortfall of 125 graduates with poultry science backgrounds (Brake and Pardue, 1998). These positions are being filled with non-traditional (i.e., non-poultry science) graduates who exhibit strong leadership, problem-solving, and communication skills. Meeker (1999) reported on a comprehensive assessment of animal agricultural industries and their need to fill managerial positions, finding that with the changing face of contemporary animal agriculture comes the need for educational institutions to produce graduates with the ability to think critically, communicate effectively, and practice team building. However, graduates of undergraduate agricultural programs often lack the necessary skills to develop this systematic approach to problem-solving. More innovative methods of instruction which embrace problem-solving must be developed

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and implemented in the college classroom. Use of research techniques in the undergraduate classroom can be an effective tool to enhance problem solving abilities and move the learner to higher

(n=57) in a senior-level animal nutrition and feeding course conducted three repeated 49 day broiler growout experiments over three semesters. Figure 1 presents instructional guidelines for the research

project presented to each student. During the first two semesters, the Animal Nutrition and Feeding (three credit hours) course was offered as two 75-minute lecture periods per week. This presented a particular challenge for scheduling data collection and bird processing. When data collection was necessary, students cooperatively agreed to block longer class periods (2.5 h) meeting earlier in the day (7AM). A 120-minute laboratory section was added for the subsequent third semester to alleviate data collection scheduling problems and offer more opportunities for experiential learning. Participation in and completion of the team research project (including submission of a team research manuscript) accounted for 20% of each student's final course grade. Upon project completion

Table 1. Expected learner outcomes of undergraduate students participating in a poultry research study.

Cognitive level ²	Expected learner outcomes
Analysis	<ul style="list-style-type: none"> · Calculate broiler performance parameters. · Test scientific hypotheses.
Synthesis	<ul style="list-style-type: none"> · Construct an appropriate scientific manuscript. · Formulate daily husbandry protocol. · Develop a strategy to address unexpected experimental occurrences. · Create an organized record keeping system. · Manage research team conflicts.
Evaluation	<ul style="list-style-type: none"> · Assess the implications of the study results. · Recommend changes to follow up experiments.

² Anderson and Sosniak, 1994.

cognitive levels of analysis, synthesis, and evaluation (Anderson and Sosniak, 1994). By its nature, research is a problem-solving entity. A successful investigator must define the problem, develop a systematic approach (i.e., experimental procedure) to address the problem of interest, conduct comprehensive experimentation, analyze the collected data, implement the results for practical application, and evaluate the success for solving the problem of interest. The educational objective of the present research project was to teach practical research skills as a model for cooperative problem solving in the college classroom. Students were presented with the task of evaluating an early feed restriction protocol for use in commercial broiler production. Systematic approaches, such as early feed restriction, to slow early growth rate and, thus minimize metabolic abnormalities and leg problems in broilers without compromising performance and carcass yield, can produce significant benefits for the broiler producer. Through this applied research project, students evaluated one solution to a practical broiler industry problem. Concomitantly, students were exposed to issues in broiler management, nutritional regimes, and current industry problems. A synopsis of expected learner outcomes is presented in Table 1.

Materials and Methods

Undergraduate students

Research Project Proposal (ANF-2)														
Title:	The effect of early feed restriction of broilers on live performance, growth parameters, and carcass yield													
Objective:	Identify practical methods to reduce feed costs without sacrificing animal performance, product quality, or livability.													
Location:	MTSU Swine Unit (Nursery Facility)													
Treatments:	1. Unrestricted feeding (<i>ad libitum</i>) 2. Early restricted feeding (60%)													
Evaluation Parameters:	Body weight Feed conversion Feed consumption Mortality Shank length Breast yield													
Project Outline:	One hundred twenty (120) broiler chicks (Cobb X Cobb) will be randomly assigned to six (6) pine litter covered floor pens (48 in X 48 in) (10 males and 10 females per pen). One of two treatments will be randomly assigned to each pen. Feed will be provided using a single manual tube feeder per pen. <i>Ad libitum</i> access to water will be provided through a automatic nipple watering system. Each pen will be equipped with a brooder to maintain temperature at 90F for the first week with a 5F reduction each subsequent week. House temperature will be maintained at 75-80F. Birds will be grown for 49 days using a three feed program (starter, finisher, and withdrawal). Feeds will be switched on a complete consumption basis. Birds will be provided 24 hours of light per day throughout the growout. Mortality will be monitored daily for calculation of period and cumulative mortality rates. Period weight and feed consumption will be used to calculate period and cumulative feed conversion.													
Project Design	<table border="1"> <thead> <tr> <th>Days</th> <th>Unrestricted Birds</th> <th>Restricted Birds</th> </tr> </thead> <tbody> <tr> <td>Day 0 to 7</td> <td><i>Ad libitum</i></td> <td><i>Ad libitum</i></td> </tr> <tr> <td>Day 8 to 17</td> <td><i>Ad libitum</i></td> <td>60% restriction</td> </tr> <tr> <td>Day 18 to 49</td> <td><i>Ad libitum</i></td> <td><i>Ad libitum</i></td> </tr> </tbody> </table>		Days	Unrestricted Birds	Restricted Birds	Day 0 to 7	<i>Ad libitum</i>	<i>Ad libitum</i>	Day 8 to 17	<i>Ad libitum</i>	60% restriction	Day 18 to 49	<i>Ad libitum</i>	<i>Ad libitum</i>
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Project Timeline:	Day 00 Chick placement Day 21 Weigh birds, measure shank length, weigh feed Day 42 Weigh birds, measure shank length, weigh feed Day 49 Weigh birds, measure shank length, weigh feed, process 8 birds (4 males and 4 females) per pen for breast yield determination													

Figure 1. Instructional guidelines for student research teams participating in a poultry research study.

Table 2. The influence of a cooperative poultry research project on learner outcome.

Survey Question	Average Response ^c (n=15)
Made the course more enjoyable	3.20
Helped with learning concepts taught in lecture	3.53
Taught techniques in animal research	2.57
Increased my interest in poultry science	2.29
Increased my desire to pursue a career in broiler production	3.00
Increased my desire to pursue a career in animal research	2.93
Helped me better work with team members	3.20
Helped me sharpen my technical writing skills	3.27
Helped me understand how research improved problem-solving skills	3.07
Increased my critical thinking ability	3.53
Demonstrated how manipulation of nutrition can influence animal performance	3.00
Should a similar study be included in subsequent semesters of this course?	Yes =87%, No=13%

^a Survey responses were quantified using a 1-4 Likert scale (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree); survey instrument was administered to 15 students in the third semester of incorporating the research project.

(after final manuscript submission), each team member subjectively evaluated fellow team members and assigned a grade (0-100%) to each. This was used, in part, by the instructor to determine individual final project grade.

Students each semester were randomly assigned to six research teams containing four members. Subsequently, treatments (early feed restricted or free choice feeding) were randomly assigned to six pens (three replicate pens per treatment). Research teams were then randomly assigned to a pen of birds. One class period was dedicated to review of experimental procedures and project expectations. One-hundred-twenty commercial strain broiler chicks and diets were obtained from a local broiler company. Research teams placed 20 chicks in their designated prepared pens at an individual bird density of 697 cm². Birds were managed according to published recommendations (FASS, 1999) and current industry standards. Research teams were cooperatively responsible for pen setup, including feeders, drinkers, litter, and brooder setup and troubleshooting, chick placement, daily bird management (e.g., feeding, checking drinkers, collecting mortalities, monitoring house temperature, etc.) and record keeping (e.g., daily mortality weights and feed offering). Dietary treatments consisted of either free choice (ad libitum) feeding throughout the study or 60% feed restriction between days 8 and 14 with a follow up return to free choice feeding. All team members were required to attend and participate in data collection on day 21 and 49 of each study. This included recording individual bird weights, calculating period and cumulative feed consumption and feed conversion, and measuring shank length. Eight birds (four males and four females) were randomly selected from each pen for euthanasia and boneless, skinless

breast removal. Pen setup, chick placement, and data collection were conducted during scheduled laboratory sessions; however, considerable outside class work was required to meet the expectations of the research project. Students were directed in calculation of performance parameters and statistical analysis. Approximately three weeks after project termination, research teams were required to submit a scientific manuscript for instructor evaluation. Students were expected to follow typical refereed journal style (Journal of Applied Poultry Research) guidelines with inclusion of an Abstract, Introduction, Materials and Methods, Results and Discussion, Conclusions and Implications, and

Reference section. Figure 2 outlines the specific guidelines for manuscript development presented to each research team member following termination of the class experiment. For purposes of comparison, data from all teams was compiled by the instructor and shared among research groups.

An instructor-developed survey instrument was administered to the most recent (third semester) class of students (n=15) during a regularly scheduled class meeting after finalized manuscripts were submitted for evaluation. The survey consisted of 12 questions with students asked to rank their responses using a four-point Likert scale (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree). The instrument was designed to quantify student opinions regarding the level of enjoyment, critical thinking, and benefits achieved through incorporation of this research project into the traditional course schedule. During the first two semesters, the instructor relied on informal questioning at study termination, not an evaluation instrument, to determine project success. Thus, quantitative data is limited to only the third semester, affecting the extent to which data can be extrapolated to reach a conclusion.

Results and Discussion

Based on the results of this course project, students' subject matter competency in animal nutrition was enhanced and valuable lessons in team work, communication skills, group dynamics, conflict resolution, problem-solving, personal responsibility, and motivational leadership were taught. Final project grades for individual students ranged from 78 to 98%. Some students received lower than average grades due primarily to poor team participation.

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The manuscript should include the following:

Title Page

Manuscript title, authors, institution. Should be a separate page. No page number.

Abstract

A brief synopsis of the objectives, procedures, and results of the study. The abstract is designed as a short summary to highlight the research without requiring the reader to read the entire manuscript. Should be 250 words or less.

Introduction

A brief introduction to the research. What research has previously been done in this area? Lay out the objective(s) for the current study. What is your hypothesis? Limit to three paragraphs.

Materials and Methods

A detailed description of what procedures were necessary to conduct the research. Include: pen design, management (e.g., litter, waterers, feeders, lighting, etc.), feeding programs, weighing procedures, processing procedures, performance/carcass parameter calculations, etc. You should include a subsection on statistical analysis (*mean, median, mode, and standard deviation for each parameter*). The materials and methods section should be detailed.

Results and Discussion

What are your results and why did you get these particular results? To adequately complete this section, you must compare your particular results with those of other teams (treatments). Are your results expected? Did you prove or disprove your hypothesis(es)?

Implications

How do the results of this research affect your target audience? This is NOT a conclusion or summary. This is an opportunity to make the results of this study applicable to the integrator, producer, or whoever the target audience.

Tables and Figures

Include any tables or figures in this section. All tables and figures should be appropriately designated (e.g., table 1-1, figure 1.1, etc.). *If you include a table and/or figure, they must be referenced in the text.*

References

All previous research/manuscripts/sources used in preparing your manuscript MUST be cited appropriately. All entries in the references section MUST be cited in the text, and vice versa. Used the following format:

Text Reference – (Jones, 1998) or Jones (1998)

When three or more authors are presented, cite as (Smith et al., 2001) or Smith et al. (2001)

Reference Section – use the following reference format

Smith, J.P., Q.W. Jones, B.A. Henry, and R.R. Roades, 2001. The effect of light restriction on broiler live performance and processing yield. *J. Appl. Poul. Res.* 22:120.

DO NOT use internet sources unless you can validate their authenticity and appropriately cite the work in your references section.

Figure 2. Manuscript preparation and submission guidelines presented to each research team member participating in a poultry research study.

This type of experience is typical in commercial poultry production.

Through the use of question-and-answer sessions during semester one and two, students participating in this project indicated they enjoyed the hands-on learning experience, gained poultry/animal knowledge, and learned how to work with a diverse group of peers to accomplish a task. When asked on course evaluations the primary reason for taking this course, 65.5% of the respondents indicated it was a necessary course in their major (75.4% of participants were Animal Science majors), 20.7% said it met general requirements, and 13.8% responded that it was a subject matter of interest. As determined subjectively, most students indicated that incorporation of the broiler study into the course was a positive addition and they learned basic principles of broiler nutrition and research techniques.

According to the results of the final project evaluation survey completed by students in the third semester of using the cooperative research approach, incorporation of an experiential animal research project into an animal nutrition and feeding course was a clear benefit to student learning. Although the number of evaluation respondents was low and the survey instrument was administered to only one semester of research teams, the results are revealing and should be used as preliminary data upon which to build conclusions. Table 2 summarizes the results of the evaluation survey. A majority of students (87%) recommended inclusion of a broiler research project in subsequent semesters. The broiler project was not particularly successful in stimulating interest in careers in poultry science

(2.29) or animal research (2.93). More importantly, however, students perceived the broiler nutrition project as beneficial for improving their technical writing skills (3.27), team work abilities (3.20), and problem-solving mastery (3.07). Student agreement was high when asked if the research project increased critical thinking abilities (3.53). Murano and Knight

Team dynamics were significantly altered by “poor” members and groups were requested to resolve conflicts internally before instructor involvement. Likewise, bird management issues (e.g., birds jumping from pen to pen, water leaks, feed outages, house temperature imbalances, etc.) periodically arose and teams were given opportunities to develop a strategy to address the issue as urgency demanded.

(1999) also found that incorporation of a cooperative team project into a food science course enhanced communication, problem-solving, and critical thinking skills. In the current study, students generally rated the broiler nutrition project as an enjoyable endeavor which assisted them in learning concepts taught in lecture.

Summary

Although student evaluation data in the present study was limited, incorporation of a cooperative applied research project into an undergraduate animal science course can enhance skills which employers seek in potential employees. Students perceived their involvement in this project as benefiting them by improving team work and problem-solving abilities. Likewise, use of research in the classroom enhanced students' systematic thought process and encouraged thinking beyond the simple knowledge level. Students were expected to apply classroom knowledge to formulate conclusions and implications for the research project results.

College instructors can see clear educational benefits in the learner by incorporating a cooperative research project into existing course formats. To avoid confusion which may stifle student benefits, instructors using the cooperative research approach, however, must efficiently organize and schedule projects which afford students clear expectations for their performance and learning. However, cooperative research can be an easy course supplement to teach research skills and achieve higher-order cognition. The current study indicates benefits of cooperative research on enhanced critical thinking; however, additional data should be collected to strengthen conclusions and validate the use of cooperative research for enhanced learning.

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