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ABSTRACT

Teachers agree that utilizing a laboratory method of teaching is both expensive and time consuming. In addition to the cost of materials, one must consider the provision of laboratory facilities and the amount of teacher and laboratory assistant time needed for preparation, facilitation, and clean-up. The need to maximize learning while minimizing cost and time expenditure for large groups of students was the impetus for this study. The objectives of this research included: (1) identify if there was a significant difference in learning between hands-on laboratory experience, live demonstration, and videotape demonstration teaching methods for nonscience major students; (2) to determine if there was a significant difference in attitude towards laboratory experiences conducted through hands-on laboratory, live demonstration, and videotape demonstration methods for nonscience major students; and (3) to compare the cost and time efficiency of live demonstration, videotape demonstration, and hands-on laboratory experience. An introduction, review of the literature, methodology, results and discussion, summary, conclusion and recommendations, and 30 references are included. (Attitude assessment instruments, the unit attitude questionnaire, pre- and posttest attitude survey responses, unit attitude questionnaire responses, laboratory cost comparisons and summaries, and a list of 30 references, are appended.) (KR)

THE RELATIVE EFFECTIVENESS AND EFFICIENCY OF HANDS-ON, DEMONSTRATION AND VIDEOTAPE LABORATORIES FOR NON-SCIENCE MAJOR STUDENTS

By

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A thesis submitted in partial fulfillment of
the requirements for the degree of

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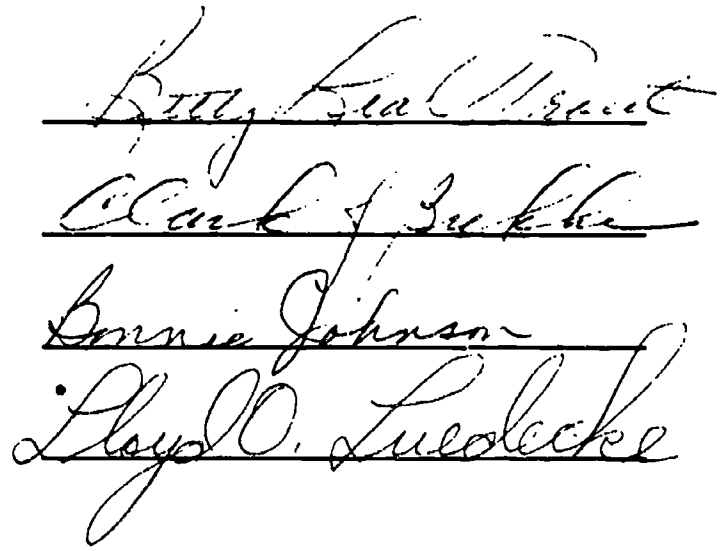
To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of HARRIET LYNN JOHNSON find it satisfactory and recommend that it be accepted.



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THE RELATIVE EFFECTIVENESS AND EFFICIENCY OF HANDS-ON, DEMONSTRATION AND VIDEOTAPE LABORATORIES FOR NON-SCIENCE MAJOR STUDENTS

Abstract

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The purpose of this study was to determine if there was a significant difference in student achievement, attitude, and time and cost efficiency between hands-on, live demonstration and videotape demonstration laboratories for non-science major students.

The study involved 64 students, predominately Hotel and Restaurant Administration majors, taking Food Science and Human Nutrition 102, Animal Products, at Washington State University during Spring semester, 1991. The subjects were stratified by gender, class and major and randomly assigned to three different laboratory sections. Each section experienced the three different teaching methods--videotaped demonstrations, live demonstrations, and hands-on experiences--for the duration of one 4-week block each in the three subject areas of dairy, meats, and eggs and poultry.

Achievement was assessed at the end of each of the three blocks by means of an instructor developed paper and pencil test. The *F*-test for comparing the means for the three methods indicated no significant differences in learning between the three methods.

A survey instrument, developed by the author to assess student attitudes towards perceived method effectiveness, efficiency and enjoyment, was administered at the beginning and end of the course. A test for marginal homogeneity, comparing these pre- and posttreatment responses, indicated that the subjects did not consider the videotape or hands-on method as effective or efficient as live demonstration. Unit questionnaire responses verified that time efficiency and personal interaction were the most important factors to students in determining satisfaction with a particular teaching method.

Records of cost and time expenditures for each laboratory showed videotape demonstrations to be the most economical, in terms of both time and expense. The live demonstration saved close to 50% of the cost of the hands-on method.

Teaching of the three investigated methods, under the conditions of the study, appeared to have no significant affect on the learning achieved by students.

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Chapter I

INTRODUCTION

Teachers agree that utilizing a laboratory method of teaching is both expensive and time consuming. In addition to the cost of materials, one must consider the provision of laboratory facilities and the amount of teacher and laboratory assistant time needed for preparation, facilitation and clean-up. The impact on the department budget is even more significantly pronounced in courses with large enrollments, necessitating multiple laboratory sections. In a university setting, when a department teaches a service course, comprised exclusively of non-majors, the allocation of such a large portion of resources is particularly disconcerting.

Hands-on laboratory experience has long been advocated as the preferred method of teaching science. Blosser (1983), claims that school laboratories have been used since the late 1800's: "Laboratory instruction was considered essential because it provided for training in observation, supplied detailed information, and aroused pupils' interest--reasons for using the laboratory that are still accepted almost 100 years later" (p. 166). In today's educational system, with the advent of more varied teaching

strategies and technological advances using media as a teaching tool, who is to say that these objectives cannot be met as well by some more cost effective method.

Hands-on laboratory experiences tend to fall somewhere between two distinct approaches: illustrative verification and investigative inquiry. The types of learning gained from either may be declarative (knowledge) or procedural (skills and abilities). Research continues (Glasson, 1989; Tamir, 1977) to determine the relationship between teaching approach and desired learning achievement. Little research has been done though to relate these factors to laboratory experience for the non-science major student.

Numerous studies have been conducted over the past decades comparing the effects of hands-on work in the laboratory with other instructional methods. As the reviewers (Hofstein and Lunetta, 1982) state, "Most of these research studies have shown no significant differences between the instructional methods as measured by standard paper-and pencil tests in student achievement, attitude, critical thinking, and in knowledge of the processes of science" (p. 202). Because the laboratory method has not been statistically supported as superior to other classroom instructional methods, in some cases science educators have tended to question the value of laboratory work. Hofstein and Lunetta (1982) advise, "If a strong affirmative response cannot be provided, then it is important to continue to

search for greater understanding through carefully designed research studies" (p. 202).

Statement of the Problem

The purpose of the study was to determine if there is a significant difference in student achievement, attitude and efficiency between hands-on laboratories, live demonstrations, and videotape demonstrations for non-science major students. The need to maximize learning while minimizing cost and time expenditures for large groups of students was the impetus for the study.

Objectives

Objectives of this research included:

1. To identify if there was a significant difference in learning between hands-on laboratory experience, live demonstration and videotape demonstration teaching methods for non-science major students.
2. To determine if there was a significant difference in attitude towards laboratory experiences conducted through hands-on laboratory, live demonstration and videotape demonstration methods for non-science major students.
3. To compare the cost and time efficiency of live demonstration, videotape demonstration and hands-on laboratory experience.

Research Hypotheses

Three hypotheses were tested in this study:

1. For non-science major students there will be a significant difference in learning between hands-on laboratory experience, live demonstration and videotape demonstration methods, as measured by objective testing.
2. For non-science major students there will be a significant difference in attitude towards hands-on laboratory experience, live demonstration and videotape demonstration methods, as measured on a Likert scale.
3. For Food Science and Human Nutrition (FSHN) 102, Animal Products, the efficiency of live demonstration and videotape demonstration teaching methods will be greater than that of hands-on laboratory experience, as measured by monetary cost and time data comparison.

Definitions

Hands-on Laboratory: After an introduction to the learning activity and a brief demonstration, students perform the directed activities in a laboratory setting, interacting directly with the instructor and teaching assistant. A planned question and review session follows the laboratory.

Live Demonstration: After the introduction to the learning activity, students observe the instructor demonstrate the laboratory activities; usually followed by a

question and review session. Interaction between the instructor and students occurs during the demonstration and the question and review session.

Video demonstration: Students view the videotaped introduction, demonstration and summary discussion of laboratory activities, followed by a live question and review opportunity. Interaction opportunities between the instructor and students are limited to the live review session.

Non-science Major Student: Students whose major is not scientific in nature.

Effectiveness: the degree to which course instructional objectives are achieved.

Efficiency: Cost and time effectiveness related to the number of students served and the use of human and material resources (time, supplies and facilities) for the learning achieved.

Laboratory Sections: Different laboratory time periods to which student groups were assigned.

Limitations of the Study

The results of this study were limited to predominately Hotel and Restaurant Administration students taking the required FSHN 102, Animal Products course at Washington State University, Spring, 1991. These findings may provide input and impetus for further study or consideration of change for other college courses.

Since FSHN 102 is taught by two professors, the students were exposed to different instructional behaviors during the methods comparison. For any one unit, however, the three teaching methods were taught by the same instructor. No attempt was made to assess, standardize or ameliorate any effects of differences on the resulting achievement or attitudes developed by students toward the three instructional techniques. As with other methodological comparison studies, it is difficult to determine what influence specific teaching behaviors have over these variables compared to the effects of the methods themselves.

Significance of the Study

The comparison of the research findings from the study of traditional hands-on laboratory experience, videotape information and live demonstration teaching methods can be used to plan laboratory experiences in the FSHN 102, Animal Products course. Utilizing the findings, the most effective and efficient method can be selected for the various laboratories.

Findings from this study may also have implications for teaching of laboratory courses in other subject matter areas at other grade levels, junior high through college.

Chapter II

REVIEW OF RELATED LITERATURE

The History of Laboratory Experience

The laboratory method of teaching has long been considered an effective method of teaching science, vocational education, business and the arts. While we know that laboratory experience, as a method of teaching, has been accepted in schools since the late 1800's, we may not be as aware of the vacillations in instructional approach this method has undergone over the years. Bradley (1968), in examining the history of the role of the laboratory in the teaching of science, confirms that individual laboratory work for the college student became common in the late 1800's and early 1900's. A number of factors which influenced the development of laboratories at this time included: the founding of technical schools such as Rensselaer Polytechnic Institute (1824) and Massachusetts Institute of Technology (1862); the passage of the Morrill Act in 1862; and the increasing importance of science in industry and everyday life. It was during this period, between the late 1800's and early 1900's, Hofstein and Lunetta (1982) state, that the laboratory tended to be inquiry oriented. Moving into the post-World War I era,

laboratory activities became used predominately for verifying or illustrating textbook material or information learned from the teacher. This trend continued, under great criticism from many scientists and educators alike, until World War II, and the advent of the atomic age swung laboratory use back towards the inquiry approach.

In 1960, the 59th yearbook of the National Society for the Study of Education, Rethinking Science Education, was produced. Blosser (1980) states, "Although the statement 'there is no one method of teaching science that can be considered unquestionably superior to all others' appeared in several places in this yearbook, there was continued emphasis on laboratory teaching" (p. 12). The yearbook authors identified five purposes that they deemed every laboratory exercise should have:

1. to add reality to textbook material
2. to develop first-hand familiarity with tools, materials, and techniques of science
3. to allow students to demonstrate to themselves something they already know to be true
4. to give students opportunities to pit their laboratory skills against par in seeking experimental answers
5. to create opportunities wherein students predict events or circumstances and then design experiments to test the accuracy of their predictions. (Henry, 1960, pp. 245-247)

The fifth purpose was considered by many educators to be the most compelling for using science laboratory activities.

Additionally, the yearbook attempted to deal with an issue in science education raised in the early 1900's and again in the early 1950's: should science be geared for the scientist or for the citizen? The question was posed, "Should the objectives of science teaching be the same for all students; for the potential scientist vs. the layman?" According to Blosser (1980), the authors "...conceded that critics said that science teaching should be oriented toward the intellectual processes (creative or intuitive thinking) and suggested that the purposes of science teaching need to be clarified" (p. 13).

The Purpose of Laboratory Experience

The debate still rages today as to the purpose and use of the laboratory - inquiry, verification, or neither. Tamir (1977) defines the two predominant approaches:

> For example, in a typical verification laboratory, the teacher identifies the problem to be investigated, relates the investigation to previous work, conducts demonstrations, and gives direct instructions, while students repeat the teacher's instructions or read aloud the directions from the manual. On the other hand, in a typical inquiring laboratory, the teacher asks the students to formulate problems, to relate the investigation to previous work, to state the purposes of the investigation; and the students actually identify the problem, state the purpose, predict the results, identify the procedures, and perform the investigation. (p. 311)

In practice, laboratories may tend to follow predominately one approach or the other, but rarely fall on the extreme ends of either spectrum.

According to Hofstein and Lunetta (1982), the investigative laboratory provides unique opportunities for training in science processes, problem solving, manipulative skills, and appreciation for science not easily available through any other method.

In Tamir's (1977) study, he attempted to determine to what extent laboratories were inquiry oriented and whether or not the inquiry level increased with the grade level. Tamir postulated that we might expect, as students move from elementary through high school to college, that their science laboratory experiences will become increasingly inquiry oriented. This progression may be due in part to their developing formal reasoning capabilities (Toothacker, 1983), but is also determined by the behavior and instructional objectives of the teacher. The results of Tamir's study showed that, for his subjects, the level of inquiry gradually increased from the ninth- to the eleventh-grade level, but regressed to highly traditional confirmatory laboratory experiences once they reached college.

Pickering (1980) states that in a good laboratory course, the book or teacher acts somewhat like a guide in a foreign country; pointing out what to look (and look out) for, not what the visitor is to see. This type of discovery can be achieved by posing carefully defined questions and providing known methods to answer them, something few

professors and even fewer teaching assistants have been trained to do. Pickering (1980) adds, "The difference is subtle but immensely important" (p. 80) between this and the directive "cookbook" approach.

Pickering (1980) goes on to state, "The job of lab courses is to provide the experience of doing science" (p. 81). He acknowledges that the vast majority of students in most college lab classes are non-science majors. It is for this reason, Pickering argues, that the laboratory has been compromised when it is used to "illustrate" lecture courses or teach manipulative "finger skills". These are not the strengths of the laboratory method of teaching, thus when it is used to achieve these goals, the result is often unsatisfactory and disillusionment occurs. "For the topics that can be illustrated, surely demonstrations or audio-visual aids could be used" (Pickering, 1980, p. 80).

In relation to the "pure" inquiry laboratory, Ausubel (1968) states:

> The immature or unsophisticated student is only confused by the natural complexities of raw, unselected, and unsystematized data. Before he can discover generalizations efficiently, the problem must be structured for him, and the available procedures and methods of handling data must be skillfully "arranged" by others, that is, simplified, selectively schematized, and sequentially organized in such a way as to make ultimate discovery almost inevitable. Most students below the graduate level of instruction lack both sufficient sophistication in science and sufficient ingenuity and originality autonomously to devise all of the experiments that are necessary for learning the process of science; and even if they could, the procedure would be much too time-consuming

> to warrant the modest advantages in understanding and appreciating scientific method that such an approach would confer over "arranged" laboratory work. (p.344)

Since the investigative laboratory seems illusive at best, should we resign ourselves to verification and give up? Olson and Bruner (1974) state, "Information picked up from experience is limited in important ways to the purpose for which it is acquired..." (p. 127). They go on to note that any information acquired through experience has two distinct facets, 1) that of knowledge, and 2) that of skills and abilities. Olson and Bruner (1974) cite experiments done by Duncker, by Maier, and by other students of thinking and problem solving to illustrate this. Knowing that the conventional use of a pliers is as a gripping tool makes it difficult to perceive them as a pendulum bob. "Knowledge per se does not make it possible to solve problems" (Olson and Bruner, 1974, p. 127). Note that skills and abilities are not specifically intended to refer only to "finger skills" but to the skills of observation, decision making, problem solving, and analysis. For this reason, identifying one's purpose is essential to realizing and acknowledging the strengths and limitations of the laboratory. Are we willing to settle for simply concept confirmation and development of some low level manipulative skills then from the verification laboratory? Today critics still say that the returns from most hands-on laboratories are not great enough for the effort or the expense.

Alternatives to the Hands-on Laboratory

Although many scientists still advocate hands-on laboratory experience, they also cite several reasons for its discontinuation. Gardner (1979) states that inflation and the taxpayer revolt are taking their toll. Combined with constantly escalating costs of chemicals and equipment (Pickering, 1984), it is easy to see how administrators are attracted to replacing hands-on experiences with demonstrations and simulations. University students seriously question the fairness of receiving one credit for three hours of lab work when the same amount of credit is given for only one hour of lecture (Leonard, 1981). In addition, fitting extended time periods for laboratory instruction into already busy schedules is difficult for both students and professors. For the amount of time students spend in the laboratory, they acquire much less information and develop fewer concepts than by a standard lecture approach (Leonard, 1981). The time the professor or teaching assistant spends ordering and inventorying laboratory material, repairing or servicing equipment, preparing the laboratory setting for the students, monitoring progress during the laboratory, and cleaning up, might better be spent in pursuing research, teaching other classes, or fulfilling other professional duties. Safety monitoring and the potential for hazard and liability also require constant attention.

Modeling, Media and Learning

What options should be considered in deciding to supplement or replace hands-on laboratories? Again, knowledge of purpose is essential. Olson (1973) states:

> One may learn that a stove is hot by (1) touching it, that is, through direct contingent experience (reinforcement if you are a behaviorist); or (2) by seeing someone recoil from touching it, that is, through modeling or observational learning; or (3) by hearing the sentence "The stove is hot." The important point is that as to the knowledge conveyed, these forms of experience converge; as to the skills they develop, these forms of experience diverge. The mental processes whereby that information is extracted is quite different in the three cases. Any experience involves both knowledge and skill. But while quite different forms of experience can generate the same knowledge, every different form of experience generates different skills. The amount of knowledge obtained from any experience increases as you move from reinforcement, to modeling, to symbolic systems.(p. 35)

If the purpose for instruction is primarily knowledge based, supported by skill attainment, one must determine if the skills developed by alternative methods, modeling or symbolic systems, meet our instructional goals. Optimal learning may result if a match is made.

Bandura supports Olson's assertion when he states, "Anything that can be learned from direct experience can also be learned by indirect or vicarious experience" (1977, p. 12). Learning can result more efficiently by this method too since much of the trial-and-error process involved in learning by direct experience is eliminated.

Olson and Bruner (1974) advocate symbolically coding information as another alternative to learning directly;

that is, by transmitting information via media - the spoken or written word, film, or diagram. Olson and Bruner state, "It is learning through these symbolic systems that most readily substitutes for direct experience in formal schooling" (p. 131). The use of language alone, while it is less useful than direct experience for developing abilities, has the advantage of ordering information more compatible to the development of abstract thought. By presenting either the live demonstration or video demonstration with an effective symbolic representation, such as a discussion or seminar prior to and after the modeling, the observational learning is maximized.

Bradley (1965), in his research on lecture demonstration versus individual laboratory work in a general education science course, determined that student learning and retention differed very little between methods, as measured by a paper and pencil test. He admits that, possibly, achievement of objectives specific to the laboratory were not measured with sufficient accuracy to reveal tendencies. He does assert that since the demonstration method held its own with the laboratory method in immediate learning and the fact that it does present a means of considerable savings in equipment, physical plant and instructor time may offset any advantages of the hands-on laboratory not revealed in his study.

Bradley (1968), continuing in his efforts to answer the question "Is the science laboratory really necessary for a general education science course?", identified five aims of the general education survey type course for non-majors. They included:

> 1. information, 2. development of interest in science, 3. understanding of relationships of science to environment and everyday life, 4. understanding of the relationships of the sciences, and 5. culture. (p. 59)

He attempted to determine, through his research review, whether the lecture-demonstration method might meet his five aims as effectively as the individual laboratory method. With the research available at the time, he found the results to be inconclusive, offering support for both methods.

Schramm (1977), commenting on the fact that most media comparison studies to date had been fruitless, states that "Learning seems to be affected more by what is delivered than by the delivery system" (p. 273). According to Salomon (1974), research done by E. French and G. Salomon shows that it is the symbol system rather than the technologies of transmission which are critical to effective understanding. Real differences in learning result from the differences in the mental processes or skills required to extract the information from the different symbol systems.

Tobias (1982) states:

> External differences between instructional treatments, whether they are educational media, methods of

> organizing classrooms, or technological devices, are important only in terms of the degree to which they influence the student's cognitive activities while engaged by the instructional content. When a particular method, medium, or technological device is successful, that success is probably attributable to the fact that it has stimulated students to more actively attempt to comprehend the material than has a comparable method. (p. 6)

He suggests that, conversely, external differences between instructional treatments that lead to similar cognitive processing will result in similar achievement, regardless of superficial differences between methods. Given the long-standing research comparing effectiveness of teaching methods, perhaps this helps explain in part the lack of significant difference. Ksobiech (1976) and Salomon (1981) both reported that student attitudes or beliefs about the different demands placed on them by different media influence the amount of effort they put forth in learning. The more difficult they perceive the media, the more effort they put forth, and consequently, the more learning they achieve. Because too often videos have been seen as a means of passive information delivery, Arnheim (1974) recommends that, to combat this, it is necessary to present a strong, relevant, interesting enough presentation, deserving of an attentive response, and that the mind of the viewer must be prepared for what the image has to offer. Ausubel (1968) adds that as "advance organizers" are an effective aid in learning written material, they are even more useful when preceding visual communication.

Clark and Salomon (1986) cite research wherein student achievement and enjoyment of an instructional medium were negatively correlated. For example, students who do not like television as much will learn more from it than from a voice recording, which they like more.

Advantages and Disadvantages of Videotaped Teaching

Video is a relatively new instructional media, hence, there are still many controversies as to the advantages and disadvantages of its use. Menis (1982), in his research on substituting closed-circuit television (videotapes) for the science laboratory, cites as advantages the ability to focus pupils' attention on important details, while neutralizing effects of the surroundings, and the capacity to enlarge small items to the size of the screen. Spitzer, Bauwens, and Quast (1989) identify the ability of the medium to help cope logistically and financially with increasing student course demand, thus allowing larger class sizes.

Kemp and Smellie (1989) recognize video teaching as unique in providing opportunities for uniform, standardized teaching for all students; reducing the length of time required for instruction; being able to provide instruction when and where desired and necessary; helping students visualize complex relationships; changing the role of the instructor in positive directions; and enabling students to experience real world problems in a safe, manageable and cost effective manner.

Opponents of video and other technology use argue that it stifles creativity, rewards conventionality, and encourages rote performance (Kulik, Kulik, and Cohen, 1980). Arnheim (1974) believes that, by the use of media, we restrict access of the student to the presenter. Lewis (1985), in his research with college faculty to determine perspectives on the role of information technologies in academic instruction, found that they had reservations about the way the technologies have encouraged behaviors they see as antithetical to the goal of educating discerning citizens. Passivity, poor reading and writing habits and preferences for predigested information are among the contemporary societal ills to which they see video and other educational technologies contributing.

Summary

Research has shown that the comparison of teaching methods is not an easy task. One must consider the purpose, the situational and instructional context, the student's learning needs, and be cognizant of the strengths and weaknesses of specific methods. Clark and Salomon (1986) state, "...learning from instruction is a much more complicated process that often involves interactions between specific tasks, particular learner traits, and various components of medium and method" (p. 465). Arnheim (1974), speaks of visual media specifically, but could be referring

to any instructional method, when he reminds us, "Basically, the image is a tool, not a teacher" (p. 187).

Chapter III

METHODOLOGY

Purpose of Study

The purpose of the study was to determine if there was a significant difference in student achievement, attitude, and cost and time efficiency when using the various teaching techniques of hands-on laboratories, live demonstrations, and video demonstrations. The major objectives were (a) to identify if there was a significant difference in learning between the three teaching methods, (b) to identify if there was a significant difference in student attitude towards these methods, and (c) to determine which method was most cost effective for its educational gains.

Subjects

Subjects included those students enrolled in FSHN 102, Animal Products, at Washington State University during Spring semester, 1991. Of the 66 subjects, 28 male and 38 female, involved in the study, 2 were freshmen; 19, sophomores; 28, juniors; 16, seniors and one fifth-year student. Most students were Hotel and Restaurant Administration majors (64%). The subjects were stratified by gender, class and major and randomly assigned to three different laboratory sections. This ensured, as much as

possible, an equal proportion of male and female, and under- and upperclassmen in each section. The composition of each laboratory section, by class, gender and major, is shown in Table 1.

Table 1

Composition of Laboratory Sections by Class, Gender & Major

	Laboratory Section		
	1[a] Wednesday p.m.	2[b] Thursday a.m.	3[c] Thursday p.m.
Class			
Freshman	1	1	--
Sophomore	6	3	10
Junior	8	9	11
Senior	8	5	3
Fifth-Year	--	--	1
Gender			
Female	11	7	20
Male	12	11	5
Major			
Hotel & Restaurant Administration	15	12	15
Undeclared	7	5	8
Agricultural Economics	--	1	1
Animal Sciences	1	--	--
Home Economics	--	--	1

[a] $n = 23$ [b] $n = 18$ [c] $n = 25$

Experimental Design

The laboratory portion of FSHN 102 had three 4-week "blocks" that were divided along commodity lines of (a) dairy, (b) meats, and (c) eggs and poultry. These blocks made up the last 12 weeks of a 15-week semester. Students in each of the three laboratory sections experienced all three different teaching methods--videotaped demonstration, live demonstration, and hands-on experience--for the duration of each 4-week block, resulting in a Latin square design (Section X Method X Unit). The rotation sequence of methods was randomly assigned for each laboratory section, and all three methods were utilized during any one block (Table 2).

Table 2

Assignment of Teaching Method to Laboratory Sections

Block	Laboratory Section 1	2	3
Dairy	Hands-on	Videotape	Demonstration
Meats	Videotape	Demonstration	Hands-on
Eggs & Poultry	Demonstration	Hands-on	Videotape

The student learning objectives, text, assignments, laboratory manual content, and hour exams were identical for all three methods. The laboratory manual was evaluated and the text modified to reflect the more passive observer role

of the videotape and live demonstration methods compared to the active participatory role of the hands-on technique. The manuals were assembled for each of the different laboratory sections, combining the active and passive components, depending on the sequence of teaching methods assigned to that laboratory section.

The format for each weekly laboratory session, regardless of the method, included an introductory discussion, the laboratory itself, a summary discussion, then an opportunity for questions and review, followed by a quiz. For the videotape demonstration method, students observed videotaped introductory and summary discussions by the instructor in addition to viewing the instructor performing actual laboratory activities. At times, videotaped instructor and student discussions or student hands-on laboratory group sessions were shown. With the demonstration method, the procedures were demonstrated live by the instructor, giving opportunity for instructor and student interaction. In the hands-on laboratory, students performed the designated activities themselves and were able to interact with the instructor and teaching assistant. All treatments were taught in the Washington State University Meats Laboratory, with the exception of the hands-on treatment for the dairy unit which was taught in a laboratory in Clark Hall.

The two professors, Dr. Lloyd Luedecke and Dr. Clark Brekke, instructed all laboratories in addition to the lecture portion of the course. Dr. Luedecke taught the dairy portion and Dr. Brekke taught the meats and the eggs and poultry portions. They have taught this course together, in this manner, each spring semester for the past 15 years.

The laboratory teaching assistants, although different for each section, remained with the laboratory section throughout the three laboratory blocks during the semester. The teaching assistants helped in laboratory set-up, facilitation of the activities including student interaction, and clean-up. They were also responsible for developing, administering and grading the quiz for each laboratory.

Instrument Development

The objectives of the attitude survey were to determine the students' attitudes toward the effectiveness and efficiency of hands-on laboratory experience, live demonstration or videotape demonstration and the students' perceived enjoyment of each teaching technique. Finding no standardized instrument which met these goals and after consulting several methods texts, the author developed the survey instrument, using Ruth E. Martin's questionnaire, Attitudes toward Presentation Method (1980, p. 39) as a model. Statements were posed in both positive and negative

terms for each of the three objectives in relation to the three separate instructional techniques. A five point Likert scale ranging from (1), *strongly disagree* to (5), *strongly agree* was utilized. Ratings for negatively stated items (even numbered) were reversed during scoring to maintain consistency with ratings of their positively stated counterparts.

The first draft of the attitude survey was submitted for evaluation to Dr. Kathy Beerman, Food Science and Human Nutrition, because of her expertise in survey construction. A refined draft was then administered to a team of six graduate students, to evaluate readability, question style and questionnaire format. After further revision the instrument was again presented to Dr. Beerman; Dr. Jim Long, Adult and Continuing Education evaluation specialist; Dr. Marc Evans, the consulting statistician; and to members of the author's graduate committee: Betty Lea Trout, Dr. Luedecke and Dr. Brekke. Following Dr. Evans' suggestion, the questionnaire items were rotated to yield three different questionnaire forms, utilizing the ordering format of Form 1 for scoring (see Appendix A).

The three forms were pilot tested with approximately 200 students in Dr. Beerman's FSHN 130 class, yielding 150 completed surveys. The Statistical Package for Social Sciences (Norusis & SPSS, Inc., 1990) was utilized for data analysis. A Kendall's Tau correlation (Ott, Larson, and

Mendenhall, 1987) was computed to determine reliability. An analysis of variance (ANOVA) was used to determine if the response across the three questionnaires was essentially the same when looking at the individual questions.

Data Collection Procedures

Students in FSHN 102 were administered the attitude survey during their laboratory sessions prior to beginning the three 4-week rotations of treatment (pretest) and again at the end of the last laboratory of the semester (posttest) to determine if any significant difference in attitude resulted from exposure to the different teaching techniques. An informal assessment of attitude, using a sentence completion format, was administered at the conclusion of each treatment block (see Appendix B). These responses were used primarily to verify the consistency of the attitude posttest results, to identify perceived positive and negative aspects of the method and to identify suggestions for improvement of each technique.

Student learning achievement was evaluated at the end of each of the three blocks using a one-hour exam. Questions covering laboratory material were developed by the instructors and embedded in the lecture and laboratory exam, then extracted for analysis.

A total of 66 students were in the sample, but data from two subjects was excluded because of incomplete

information, resulting in a total of 64 participants in the study.

Records of cost and actual and estimated time expenditures for the three treatments of each laboratory were kept by Dr. Luedecke, Dr. Brekke and the laboratory teaching assistants. "Actual time" was recorded as the time spent in preparation, conducting and clean-up of the laboratory, not adjusting for any work already done for a preceding method. "Estimated time" reflected the anticipated time disbursement, given that no work had been done for a previous laboratory or would be done for a subsequent laboratory.

Data Analysis

The data were analyzed using the SAS (SAS Institute Inc., 1985) computer program with the assistance of Wayne Tate, computer programmer, and statistician, Dr. Marc Evans, of Washington State University's Statistical Services.

Chapter IV

RESULTS AND DISCUSSION

The goals of this study were to determine if there is a significant difference in learning effectiveness, attitude, and cost and time efficiency between hands-on laboratory experience, live demonstration and videotape demonstration teaching methods. The results of this research study are reported based on statistical analyses of test scores and assessment responses, and examination of descriptive data, relating to the hypotheses.

Analysis of Achievement Data

Scores on test items covering laboratory material learned in the dairy, meats and the eggs and poultry units were extracted, respectively, from two one-hour exams and the two-hour final exam. Test questions were instructor developed, mainly multiple choice and true-false format. Test percentage means (raw data) for each of the units, based on the specific teaching method assignment for the three laboratory sections, are given in Table 3.

Table 3

Test Percentage Means by Laboratory Section, Unit and Teaching Method

Unit	Laboratory Section 1	%	2	%	3	%
Dairy	Hands-on	80	Video	74	Live	75
Meats	Video	80	Live	77	Hands-on	74
Eggs & Poultry	Live	76	Hands-on	75	Video	74

There was an anticipated percentage mean difference between laboratory sections, since subjects were not stratified by an ability measure. The raw percentage means tended to vary little between teaching methods or laboratory units within a section.

The SAS (SAS Institute Inc., 1985) General Linear Models Procedure was used to examine students' cumulative laboratory test scores to determine if a significant difference in achievement existed between the three teaching techniques. An *F*-test was used to compare the means resulting solely from the effects of the three teaching methods, factoring out the effects of the laboratory section and treatment sequence and the influence of students-within-a-section on learning achievement. The *F*-test results indicated no significant differences among the means

(p=0.8766). The least-squares adjusted means and standard errors by teaching method are presented in Table 4.

Table 4

Least-Squares Adjusted Means and Standard Errors[ab] by Teaching Method

Method	Mean	Standard Error
Hands-on	30.373	.522
Videotape	30.532	.522
Live Demonstration	30.751	.522

Note. Maximum possible mean = 44.333.
[a]df = 2 [b]N = 64

The F-test was used to detect differences among means and not to determine equality among means. Therefore, a statistical power analysis (Kraemer & Thiemann, 1987) was indicated in order to evaluate the confidence with which F-test conclusions of "no difference" would be made. If this research experiment were repeatedly run, ad infinitum, and the sample means from each run averaged, the "true means" could be computed. This is clearly impossible, hence the need for statistical methods of calculation. When Dr. Brekke and Dr. Luedecke were consulted as to their opinion of the point variance required to indicate a meaningful difference among method means, they concurred on a variance of two points. If a difference of 2.0 were to exist between the largest and smallest true means, then there is a 0.775

or 77.5% chance that the experiment would have detected this difference. In other words, it is unlikely (about a 22% chance) to have a true mean difference of 2.0 or greater. Thus, the *F*-test for equality has a moderate to high power (Kraemer & Thiemann, 1987) for detecting a difference between largest and smallest means when that difference is of the order of 2.0 or greater, based on the above least-square adjusted means. Therefore, the conclusion made that there exists no significant difference in learning by teaching method is likely correct.

This achievement data analysis supports previous reviewed research findings (Bradley, 1965; Hofstein and Lunetta, 1982; Schramm, 1977) concerning differences in laboratory learning achievement using various teaching techniques. There appears to be no significant difference in achievement, as measured by a paper and pencil objective test, between hands-on laboratory experience, videotape demonstration and live demonstration. Given that the three methods for each unit were taught by the same instructor, "no significant difference" in teaching methods may have resulted from the "same instructor" control (Clark, 1991). If a moderate difference among mean test scores did exist, considering the results of the power analysis, a significant difference among methods probably would have been detected.

Attitude Assessment

Students' perspectives toward the three teaching methods were assessed to ascertain their appraisal of the effectiveness and efficiency of the methods, and their perceived enjoyment of them. Pre- and posttest Likert scale attitude surveys (three forms) and informal unit questionnaires were utilized to collect the data.

In determining instrument reliability, the Kendall's Tau correlation (Ott, Larson, & Mendenhall, 1987) yielded all positive correlations, indicating that the students responded in a like fashion to the questions expected to be similar (positive and negative pairs). Results from the analysis of variance (ANOVA) resulted in a significant difference, $p \leq 0.05$, in 6 out of 18 questions, indicating that some differences existed among responses for the three different questionnaires, even though the questions were identical, but reordered. For this reason, each subject randomly was assigned one of the three survey forms to mitigate the effects of questionnaire fatigue (respondents' answers may tend to be inconsistent as they near the end of a questionnaire) and obtain the truest response possible.

Students' pre- and posttest overall ratings of most preferred, neutral, and least preferred of the three teaching methods are shown in Table 5. A neutral stance indicated no strong preference either way. Although highest ratings remained with the hands-on and live demonstration

Table 5

Attitude Survey Overall Method Ratings[a]
Pre- and Posttest Percentages

Method	Preference	Pretest	Posttest
		%	
Hands-on	Most Preferred	53	42
	Neutral	28	31
	Least Preferred	19	26
Videotape	Most Preferred	8	13
	Neutral	17	23
	Least Preferred	75	64
Live Demonstration	Most Preferred	39	45
	Neutral	55	45
	Least Preferred	6	10

[a]*N* = 64

methods, most preferred rating percentages decreased for hands-on while neutral and most preferred percentages for the videotape method increased slightly, reflecting a somewhat less negative attitude toward the method.

Beyond these overall ratings, however, differences were observed when parts of the survey were analyzed. For example, a grouped summary of the pretest and posttest Likert scale attitude assessment responses is presented in Table 6 (see Appendix C for a detailed summary of pre- and posttest responses). *Strongly agree* and *agree* have been grouped together under Positive, and *disagree* and *strongly disagree* have been grouped under Negative.

Analysis of pre- and posttest attitude survey responses indicated that students' positive perceptions of the effectiveness and efficiency for both hands-on and videotape demonstration methods decreased while positive attitudes towards live demonstration remained stable or increased slightly. Also a large difference in posttest responses between the two videotape effectiveness questions was seen, despite moderately strong correlations between the two questions. The author has no explanation for this variation.

Pre- and posttest attitude survey responses were compared based on the test for marginal homogeneity (Bishop, Fienberg, and Holland, 1975) utilizing the SAS (SAS Institute Inc., 1985) CATMOD procedure. The test of

Table 6

Pre- and Posttest Attitude Assessment Responses[a]

Method/Item[b]	Positive		Neutral		Negative	
	Pre-	Post	Pre-	Post	Pre-	Post
	%					
Effectiveness						
Hands-on 5.	62	60	32	22	6	18
16.	71	61	10	14	18	25
Videotape 2.	52	40	26	16	22	44
9.	10	14	24	8	66	78
Live Demonstration 4.	46	48	30	21	22	31
13.	48	50	30	25	22	25
Efficiency						
Hands-on 3.	62	46	18	16	20	38
12.	63	39	14	14	23	37
Videotape 11.	46	34	28	24	26	42
18.	63	47	24	14	13	39
Live Demonstration 1.	80	84	12	6	8	10
14.	50	59	36	22	14	19
Enjoyment						
Hands-on 8.	80	76	8	14	12	10
17.	82	76	14	10	4	14
Videotape 6.	49	36	22	18	29	46
15.	29	26	34	18	37	56
Live Demonstration 7.	78	78	20	12	2	10
10.	82	74	8	14	10	12

[a]N = 64 [b]Refers to numbering of attitude survey items, Form 1 (Appendix A).

marginal homogeneity was used to determine whether students' pretest attitudes were the same as their posttest attitudes. If there was a significant difference, this implied that a change of attitude had occurred between testing periods. Chi-square values for the test of marginal homogeneity are listed in Table 7.

Concerning ranking of the methods' effectiveness, both questions concerning the videotape method were significantly different, $p \leq 0.05$, with a sharp negative shift towards the strongly disagreeing scale. For hands-on effectiveness, one question was significantly different at the $p \leq 0.10$ level, showing a negative shift towards the disagreeing side. For live demonstration, both questions were non-significant. This data indicated that students felt that they could not achieve the instructional objectives as well by means of videotapes or hands-on experience as they could by observing a live demonstration.

As for the methods' efficiency, students' perceived attitude toward live demonstration was significant for one question at the $p \leq 0.05$ level, with a distinct positive shift towards the strongly agreeing side. Videotape efficiency was significantly different for one question, and hands-on efficiency was significant for both questions at $p \leq 0.05$ with a definite negative shift towards the disagreeing side of the scale. Students perceived that they learned more for the time spent observing live demonstrations than they

Table 7

Chi-Square Values for Test of Marginal Homogeneity
Attitude Survey Pre- and Posttest Responses[ab]

Method/Item[c]		Chi-Square Values
Effectiveness		
Hands-on	5.	8.63**
	16.	5.53
Videotape	2.	18.45*
	9.	19.02*
Live Demonstration	4.	4.90
	13.	2.90
Efficiency		
Hands-on	3.	12.61*
	12.	14.60*
Videotape	11.	7.33
	18.	19.54*
Live Demonstration	1.	10.87*
	14.	5.75
Enjoyment		
Hands-on	8.	2.19
	17.	6.05
Videotape	6.	12.28*
	15.	11.14*
Live Demonstration	7.	7.31
	10.	1.60

[a]$df = 4$ [b]$N = 64$
[c]Refers to numbering of attitude survey items, Form 1 (Appendix A).
*Significant at $p \leq 0.05$. **Significant at $p \leq 0.10$.

initially judged. Student perceptions further indicated that they felt they learned less from videotapes and much less from hands-on experience for the time spent, than first thought.

In terms of students' perceived enjoyment of the three methods, both questions for the videotape method were significantly different at the $p \leq 0.05$ level, with a negative shift towards the strongly disagreeing scale. The questions pertaining to hands-on experience and live demonstration indicated no significant difference. Live demonstrations and hands-on experience appeared to be enjoyed about equally compared to videotapes, which were enjoyed less than initially expected.

In conclusion, comparing the pre- and posttest responses of the attitude survey, the statistical results indicated that the students did not consider the videotape or hands-on methods to be as effective or as efficient as live demonstration. In fact, students' perceptions toward the efficiency of live demonstration were the only significantly different posttest responses to grow more positive. Students also indicated less enjoyment of the videotape method than with the hands-on or live demonstration methods.

These results were also supported by the narrative responses to the informal unit attitude questionnaires administered at the end of each 4-week laboratory treatment

block. The most frequent comments (see Appendix D) were similar among laboratory sections.

The hands-on method was constantly identified by the students as "the best way to learn," citing increased retention as the reason for "learning by doing". However, the students invariably complained about the amount of time spent in lab, the cold temperature of the Meats Laboratory and that they had to stand so long.

The most outstanding feature of the videotape method identified by the students was that it took less time in laboratory than either the hands-on or live demonstration methods. On the negative side, students felt it was more difficult to pay attention without having the instructor "in living flesh." They hesitated to interrupt during the videotape, so felt they missed a lot by not being able to ask questions immediately. Sound quality and camera problems also detracted from the experience.

For the videotape laboratory, every effort was made to maintain similarity with the other treatments, even to the extent of having the students go to the Meats Laboratory, on the edge of campus, to watch the videotape. In an informal discussion occurring after the assessments were completed, students commented that their outlook on the videotape method may have been more positive had they been able to view it in a more convenient location with improved audiovisual facilities. For added efficiency of the

videotape, in most cases, the introduction and post-laboratory discussion of the laboratory results were included on the tape, along with the presentation of laboratory procedures, instead of being delivered live before and after showing the laboratory itself on video. This further reduced the amount of interaction between instructor and students.

Advantages of live demonstration were similar to those of hands-on. Students liked seeing what was going on "live", and some even expressed appreciation (and relief!) that they could watch an expert do the job rather than "botching it up" themselves. Almost as positive as for the videotape was the shorter length of time involvement in the laboratory period. Frequent complaints again concerned standing so long in the cold meats processing room. Unique to the live demonstration, with the given facilities and large classes, was the difficulty of students being able to get where they could see the total demonstration.

It is evident from these comments that time efficiency and instructor and student interaction are the most important factors to students in determining their satisfaction with a particular teaching method. The challenge to instructors may be that students want these factors to be fulfilled simultaneously.

Analysis of Laboratory Expenditure Data

Another objective of this study was to examine the difference in cost and time expenditures of the three teaching techniques. Cost and time output were recorded for each laboratory method and summaries of the unit and estimated total cost, total estimated time and total actual time disbursements compiled (see Appendix E). For evaluation purposes, total estimated time was utilized, since this reflected the calculated time necessary for an individual laboratory. Total actual time included time spent on activities that benefitted more than one laboratory treatment. Table 8 shows the estimated cost, estimated time and actual time by unit and totals for each method. All amounts are stated based on a single laboratory section. In order to accommodate the high enrollment demand for the course, FSHN 102 usually operates four laboratory sections per semester, resulting in cost and time expenditures nearly four times those shown.

Table 8

Estimated Gross[a] Cost[b], Estimated Time & Actual Time Totals[c] by Unit and Teaching Method

Unit	Hands-on	Videotape	Live Demonstration
Estimated Total Cost			
Dairy	$ 78.65	$ 20.00	$ 37.50
Meats	$498.07	$ 0.00	$222.67
Eggs & Poultry	$360.35	$ 0.00	$235.55
Total	$937.07	$ 20.00	$495.22
Total Estimated Time			
Dairy	35 hrs. 45 min.	22 hrs. 15 min.	26 hrs. 5 min.
Meats	58 hrs. 10 min.	18 hrs. 5 min.	58 hrs. 35 min.
Eggs & Poultry	40 hrs. 10 min.	15 hrs. 50 min.	34 hrs. 50 min.
Total	134 hrs. 5 min.	56 hrs. 10 min.	119 hrs. 30 min.
Total Actual Time			
Dairy	39 hrs.	28 hrs. 15 min.	24 hrs. 20 min.
Meats	49 hrs. 35 min.	21 hrs. 55 min.	55 hrs. 35 min.
Eggs & Poultry	31 hrs. 25 min.	21 hrs. 5 min.	36 hrs. 15 min.
Total	120 hrs.	71 hrs. 15 min.	116 hrs. 10 min.

[a] Not deducting receipts from sale of meat products.
[b] Costs for supplies and hiring of services only. Does not include cost of professors' or laboratory teaching assistants' time.
[c] Amounts are for one laboratory section.

Comparing estimated costs of the dairy, meats and the eggs and poultry units, the most expensive units for either the hands-on or live demonstration methods are the meats and the eggs and poultry units. These units cost from four to six times the cost of the dairy unit.

Although estimated times for the live demonstration method are not notably different from hands-on, the total estimated cost is nearly half the amount. Videotape offers the most distinct overall savings advantages in terms of both time and money.

The professors and teaching assistants of the course were also asked to respond to the following question in evaluating each method for each laboratory: In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently? Videotape was the only method where agreement was reached as to the feasibility of a teaching assistant managing the laboratory independently. It was also agreed that hands-on and live demonstration were best taught by the instructor, unless a very capable teaching assistant was available.

Cost and time expense are certainly considerations in choosing where to allocate budget resources, but if it were simply a matter of money, science departments would have gone a route less expensive than hands-on laboratories long ago. As stated earlier in the literature review (Blosser,

1980; Olson and Bruner, 1974; Pickering, 1980), it is imperative to identify the purpose of the laboratory. Since hands-on experience has long been the accepted "laboratory" instructional method, it has frequently been utilized no matter what the laboratory's purpose, often with less than effective, efficient or satisfactory results.

The objective of the FSHN 102 laboratory is not to teach manipulative skills, but rather to impart information and enhance learning through activities taking place in the laboratory. In light of the findings of this research study, alternatives to the traditional hands-on laboratory teaching method may be timely and advantageous to consider for FSHN 102.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of the study was to determine if there was a significant difference in student achievement, attitude and efficiency between hands-on laboratory experience, live demonstrations, and video demonstrations for non-science major students. The need to maximize learning while minimizing cost and time expenditures for large groups of students was the impetus for the study. Objectives of this research were to:

1. Identify if there was a significant difference in learning effectiveness between hands-on laboratory experience, live demonstration and videotape demonstration teaching methods for non-science major students.
2. Determine if there was a significant difference in attitude towards laboratory experience conducted through hands-on laboratory, live demonstration and videotape demonstration methods for non-science students.

3. Compare the cost and time efficiency of live demonstration, videotape demonstration and hands-on laboratory experience.

The sample consisted of those students enrolled in FSHN 102, Animal Products, at Washington State University during Spring semester, 1991. Subjects were stratified by class, gender and major and randomly assigned to three different laboratory sections.

Each of the laboratory sections experienced instruction in the areas of dairy products, meats, and eggs and poultry, for a four-week period each, using one of the three different teaching methods: hands-on experience, videotape demonstration and live demonstration.

Students were administered both a pre- and posttest attitude survey to determine initial preferences and their change through time and experience. Achievement data on laboratory learning was extracted from two one-hour exams and the two-hour final exam. Cost and time expenditure data was compiled by the instructors and teaching assistants throughout the course of each laboratory.

Data was analyzed using SAS (SAS Institute Inc., 1985). Findings were examined using frequencies and percentages, and tests of significance were conducted at the $p \leq 0.05$ level utilizing an *F*-test, and at the $p \leq 0.05$ and 0.10 levels for a test for marginal homogeneity. Significant findings were so noted.

Research Conclusions

Conclusions reached from the data analyses are as follows:

1. There was no significant difference in academic achievement between students taught by hands-on laboratory experience, videotape demonstration or live demonstration teaching techniques, as measured by an objective paper and pencil test. It is not known what effect an essay test format might have had on achievement differences.

2. There were few significant differences between pre- and posttest attitude ratings. Students' perceptions of the effectiveness of live demonstration increased, while their outlook on hands-on effectiveness and efficiency decreased moderately. Attitudes toward videotape efficiency were more negative and perceptions of videotape effectiveness decreased most significantly. Contrary to students' perceptions though, whether positive or negative, no significant difference in achievement existed between teaching methods.

3. Descriptive data showed videotape demonstrations to be the most economical, both in terms of time and expense. This does not take into account expenditures for videotape production. Although the production expense might be considerable, the per use cost would be greatly reduced by continued utilization. If live action is preferred, live

demonstration is the best alternative, saving close to 50% of the cost of the hands-on method.

4. Live demonstration instruction is a viable alternative for hands-on laboratory experience as used with non-science majors in a service course.

5. Except for students' attitudes, videotape demonstration shows strong potential as both an effective and cost efficient alterative to the traditional hands-on laboratory. Adjustments made in technical presentation and opportunities providing for increased instructor and student interaction during the instructional process could strengthen the use of the videotape method and increase positive student acceptance.

Recommendations for Further Study

Based on the results and conclusions of this study, the following recommendations are made for further study:

1. While this study focused on the potential of one instructional method effectively substituting for another for the entire course, further research and analysis is encouraged to determine which method may be most effective for a specific individual laboratory or unit of study.

2. With the research findings available on individual learning styles, the potential of increasing achievement by utilizing a variety of teaching methods within a lesson, unit, or course calls for study and analysis in combining methods to achieve the most effective mix.

3. The findings of this study indicate that students place a high value on time efficiency and instructor and student interaction. For this study, every effort was made to maintain a "pure" videotape demonstration, even taping the laboratory introductions and post-procedure discussions. Further study is needed to examine the effects of an enhanced environment, improved technical features of the videotape itself and viewing facilities, and increased instructor and student interaction, on the students' perceived effectiveness, efficiency, and enjoyment of the videotape demonstration method.

4. Budget problems continue to face many colleges. Departments are pushed to serve more students with the same or fewer human and financial resources. Hardest hit may be the subject matter areas which traditionally teach by laboratory experience, particularly those offering service courses for non-majors. The purpose of these laboratories is generally to impart information and enhance learning through activities experienced in the laboratory. As technology continues to afford educators increasingly varied choices in teaching techniques, further study is recommended to maintain the search for more effective, cost efficient and satisfying alternatives to hands-on laboratory experience, particularly for the non-science major student.

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APPENDIX A

Attitude Assessment Instruments

FORM 1

Teaching Methods

We would like to get your opinions concerning various teaching techniques, including VIDEOTAPES, LIVE DEMONSTRATIONS, and HANDS-ON EXPERIENCE. Answer the following statements by circling the response that best fits your agreement or disagreement.

KEY:
SA = Strongly agree
A = Agree
N = Neutral: neither agree nor disagree
D = Disagree
SD = Strongly disagree

1.	Given that it takes the same amount of time, I believe learning by observing a live demonstration is superior to viewing a videotape.	SA	A	N	D	SD
2.	I feel that viewing videotapes is NOT an effective method of learning.	SA	A	N	D	SD
3.	Although it takes more time, hands-on experience is my preferred method of learning.	SA	A	N	D	SD
4.	Observing a live demonstration is NOT my most effective means of learning.	SA	A	N	D	SD
5.	I learn best through hands-on experience.	SA	A	N	D	SD
6.	I do NOT like to learn by viewing videotapes.	SA	A	N	D	SD
7.	I like to learn by observing a live demonstration.	SA	A	N	D	SD
8.	I do NOT like to participate in hands-on activities.	SA	A	N	D	SD
9.	For me, viewing a videotape is the most effective means of learning.	SA	A	N	D	SD
10.	To me, observing a live demonstration would be boring.	SA	A	N	D	SD
11.	For me, viewing videotapes is an efficient means of learning.	SA	A	N	D	SD
12.	I feel hands-on experience takes too much time for the amount of learning achieved.	SA	A	N	D	SD
13.	I learn best when I can observe a live demonstration.	SA	A	N	D	SD
14.	For me, observing a live demonstration is a poor substitute for hands-on experience.	SA	A	N	D	SD
15.	I like to learn by viewing videotapes in class.	SA	A	N	D	SD
16.	Hands-on experience is NOT my most effective means of learning.	SA	A	N	D	SD
17.	For me, learning by participating in hands-on experiences is fun.	SA	A	N	D	SD
18.	I feel viewing videotapes in class is a waste of time.	SA	A	N	D	SD

Finally, please rank order your perceived preference of the three techniques;
1, most preferred to 3, least preferred.

Hands-on ___ Live Demonstration ___ Videotape .

FORM 2

Teaching Methods

We would like to get your opinions concerning various teaching techniques, including **VIDEOTAPES, LIVE DEMONSTRATIONS,** and **HANDS-ON EXPERIENCE.** Answer the following statements by circling the response that best fits your agreement or disagreement.

KEY: SA = Strongly agree
A = Agree
N = Neutral: neither agree nor disagree
D = Disagree
SD = Strongly disagree

1.	For me, learning by participating in hands-on experiences is fun.	SA	A	N	D	SD
2.	I feel that viewing videotapes is NOT an effective method of learning.	SA	A	N	D	SD
3.	I learn best when I can observe a live demonstration.	SA	A	N	D	SD
4.	To me, observing a live demonstration would be boring.	SA	A	N	D	SD
5.	For me, viewing a videotape is the most effective means of learning.	SA	A	N	D	SD
6.	I feel hands-on experience takes too much time for the amount of learning achieved.	SA	A	N	D	SD
7.	I like to learn by observing a live demonstration.	SA	A	N	D	SD
8.	I feel viewing videotapes in class is a waste of time.	SA	A	N	D	SD
9.	I learn best through hands-on experience.	SA	A	N	D	SD
10.	Hands-on experience is NOT my most effective means of learning.	SA	A	N	D	SD
11.	For me, viewing videotapes is an efficient means of learning.	SA	A	N	D	SD
12.	I do NOT like to learn by viewing videotapes.	SA	A	N	D	SD
13.	Although it takes more time, hands-on experience is my preferred method of learning.	SA	A	N	D	SD
14.	For me, observing a live demonstration is a poor substitute for hands-on experience.	SA	A	N	D	SD
15.	Given that it takes the same amount of time, I believe learning by observing a live demonstration is superior to viewing a videotape.	SA	A	N	D	SD
16.	Observing a live demonstration is NOT my most effective means of learning.	SA	A	N	D	SD
17.	I like to learn by viewing videotapes in class.	SA	A	N	D	SD
18.	I do NOT like to participate in hands-on activities.	SA	A	N	D	SD

Finally, please rank order your perceived preference of the three techniques;
1, most preferred to 3, least preferred.

Live Demonstration ___ Videotape ___ Hands-on _

FORM 3

Teaching Methods

We would like to get your opinions concerning various teaching techniques, including **VIDEOTAPES, LIVE DEMONSTRATIONS, and HANDS-ON EXPERIENCE.** Answer the following statements by circling the response that best fits your agreement or disagreement.

KEY: SA = Strongly agree
A = Agree
N = Neutral: neither agree nor disagree
D = Disagree
SD = Strongly disagree

1.	For me, viewing a videotape is the most effective means of learning.	SA	A	N	D	SD
2.	Hands-on experience is NOT my most effective means of learning.	SA	A	N	D	SD
3.	I like to learn by observing a live demonstration.	SA	A	N	D	SD
4.	I feel viewing videotapes in class is a waste of time.	SA	A	N	D	SD
5.	Although it takes more time, hands-on experience is my preferred method of learning.	SA	A	N	D	SD
6.	For me, observing a live demonstration is a poor substitute for hands-on experience.	SA	A	N	D	SD
7.	For me, viewing videotapes is an efficient means of learning.	SA	A	N	D	SD
8.	I do NOT like to participate in hands-on activities.	SA	A	N	D	SD
9.	Given that it takes the same amount of time, I believe learning by observing a live demonstration is superior to viewing a videotape.	SA	A	N	D	SD
10.	Observing a live demonstration is NOT my most effective means of learning.	SA	A	N	D	SD
11.	I like to learn by viewing videotapes in class.	SA	A	N	D	SD
12.	I feel hands-on experience takes too much time for the amount of learning achieved.	SA	A	N	D	SD
13.	I learn best when I can observe a live demonstration.	SA	A	N	D	SD
14.	I feel that viewing videotapes is NOT an effective method of learning.	SA	A	N	D	SD
15.	For me, learning by participating in hands-on experiences is fun.	SA	A	N	D	SD
16.	I do NOT like to learn by viewing videotapes.	SA	A	N	D	SD
17.	I learn best through hands-on experience.	SA	A	N	D	SD
18.	To me, observing a live demonstration would be boring.	SA	A	N	D	SD

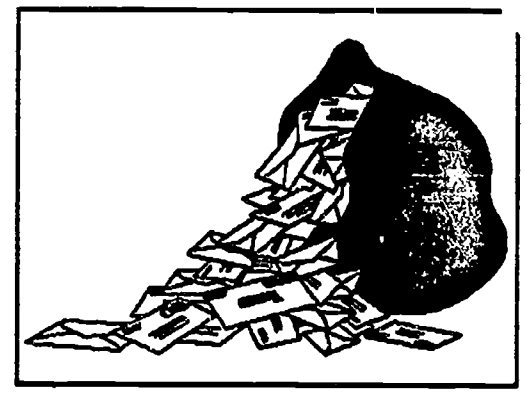
Finally, please rank order your perceived preference of the three techniques;
1, most preferred to 3, least preferred.

Videotape ___ Hands-on ___ Live Demonstration ___

APPENDIX B

Unit Attitude Questionnaire

LET'S HEAR THE NEWS!



Please complete the following unfinished statements.

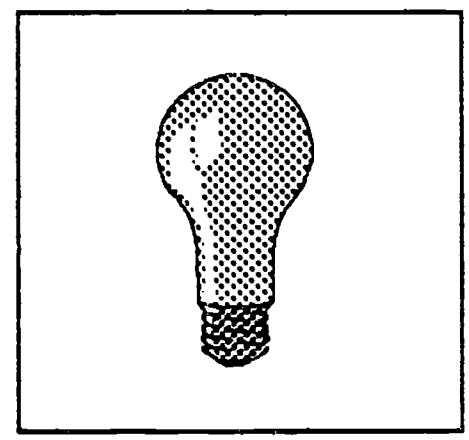
One or more things I liked about the hands-on method was:

One or more things I disliked about the hands-on method was:

To improve the hands-on method, I would suggest that:

Overall, my feelings about the hands-on method are:

WHAT ARE YOUR IDEAS?



Please complete the following unfinished statements.

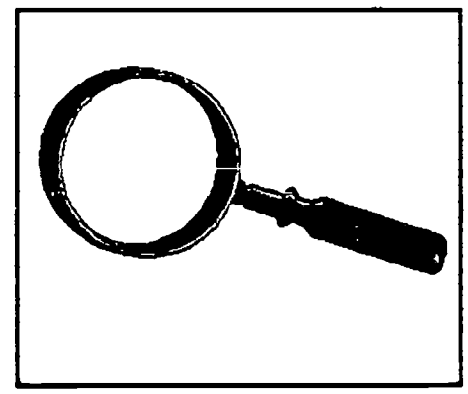
One or more things I liked about the videotaped demonstration method was:

One or more things I disliked about the videotaped demonstration method was:

To improve the videotaped demonstration method, I would suggest that:

Overall, my feelings about the videotaped demonstration method are:

IT'S TIME TO TAKE A GOOD LOOK!



Please complete the following unfinished statements.

One or more things I liked about the live demonstration method was:

One or more things I disliked about the live demonstration method was:

To improve the live demonstration method, I would suggest that:

Overall, my feelings about the live demonstration method are:

APPENDIX C

Pre- and Posttest Attitude Survey Responses

PRE- AND POSTTEST ATTITUDE SURVEY RESPONSES[a]

Method/Item[b]	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post
	%									
Effectiveness										
Hands-on 5.	22	26	40	34	32	22	4	18	2	0
16.	18	25	53	36	10	14	16	20	3	5
Videotape 2.	8	10	44	30	26	16	18	18	4	26
9.	2	4	8	10	24	8	50	42	16	36
Live Demonstration 4.	4	14	42	38	30	21	22	31	2	0
13.	6	14	42	36	30	25	22	25	0	0
Efficiency										
Hands-on 3.	28	22	34	24	18	16	20	36	0	2
12.	17	14	46	25	14	14	17	31	6	16
Videotape 11.	5	4	41	30	28	24	20	24	6	18
18.	11	11	52	36	24	14	10	22	3	17
Live Demonstration 1.	30	50	50	34	12	6	8	6	0	4
14.	6	11	44	48	36	22	12	16	2	3
Enjoyment										
Hands-on 8.	26	22	54	54	8	14	8	5	4	5
17.	30	22	52	54	14	10	3	10	1	4
Videotape 6.	11	6	38	30	22	18	18	18	11	28
15.	4	4	25	22	34	18	25	28	12	28
Live Demonstration 7.	10	18	68	60	20	12	2	8	0	2
10.	18	16	64	58	8	14	8	10	2	2

[a]N = 64 [b]Refers to numbering of attitude survey items, Form 1 (Appendix A).

APPENDIX D

Unit Attitude Questionnaire Responses

DAIRY UNIT

Hands-on Method

Responses to attitude questionnaire:

One or more things I liked about the hands-on method was:

- learning methods of testing milk and meat and actually doing them ourselves; being able to do the experiments myself; visually seeing and handling the given products, which, in turn, greatly increased the knowledge acquired.

- being active and taking part in what was happening.

- more interesting, learned more than usually do with demos and videos.

One or more things I disliked about the hands-on method was:

- took too long and some of the topics were not necessary for hotel students to need to know, ie. Milko tester; the length of the lab — my attention span did not last for the entire 2-3 hr. sessions; took a lot of time to do when it could have been taught a shorter way; waiting in lines, waiting for instruction.

- the long hours standing up doing experiments; too many notes given without a place to sit and write; seemed tiresome, hard to pay attention to what's going on because it gets uncomfortable.

To improve the hands-on method, I would suggest that:

- the lab be shortened. I believe some people may like 2 short labs a week rather than 1 long one; there has got to be something better than doing lab work. I could have taken chemistry.

- get some stools to sit on.

Overall, my feelings about the hands-on method are:

- I liked it; very positive and would like to see more of that type of teaching; should be the teaching method for all laboratories.

- it was interesting to see the bacteria in milk and meat, so it was beneficial.

- I learned a lot as I did the experiments myself and we analyzed the data, although it was hard standing up for three hours at a time; with shorter labs the attention of the students would improve.

- it's more practical than demo and video. It makes it <u>easier</u> to <u>remember</u> what you're learning because you're actually doing what you are learning

DAIRY UNIT

Videotaped Demonstration

Responses to attitude questionnaire:

One or more things I liked about the videotaped demonstration method was:

- it made class short; cut down the time spent in class.
- fast to learn; very understandable; easy to follow.
- it's convenient; if you miss it, it's easy to view later.

One or more things I disliked about the videotaped demonstration method was:

- boring; put students to sleep.
- slow pace; lack of physical activity in a lab such as this one.
- inability to ask questions during the tape.
- poor sound quality; couldn't understand; couldn't hear.

To improve the videotaped demonstration method, I would suggest that:

- more professional tapes; fix the sound quality.
- the room be more appropriate for sound.

Overall, my feelings about the videotaped demonstration method are:

- O.K., generally an interesting session but would rather have demonstration.
- good- I'm glad we didn't have to actually do the labs.
- I personally don't learn as much as if it were live, but it's O.K.

DAIRY UNIT

Live Demonstration

Responses to attitude questionnaire:

One or more things I liked about the live demonstration method was:

- it didn't take as much time as hands-on probably would; took less time.

- that I didn't have to do the lab, I could just sit and watch.- It was easy to pay attention to and take good notes; easy to understand- no need to do it myself and could still understand the theory be..ind it; no possibility for me to screw up; didn't have to "get into anything".

- the whole class saw the same thing.

- could ask questions of the instructor while the question is still "hot".

One or more things I disliked about the live demonstration method was:

- couldn't always see; the demonstrations were in front of a classroom where everyone sat at the same level and this made it difficult to see. A mirror overhead would have helped considerably.

- some things were difficult to understand; really hard to follow the dilution process, etc. unless you do it yourself - got totally lost and still don't really get it.

To improve the live demonstration method, I would suggest that:

- different kind of seating arrangement so we can see the equipment; have in a different room, not as many samples; 1) have separate stations with TAs doing the same thing 2) arrange desks differently to help viewing; either use a room with multilevel seating or a table with a mirror above.

Overall, my feelings about the live demonstration method are:

- Excellent!; O.K.; fine; better than I thought previously; better than lectures; best way to teach this class; that it is the best method - it's the most effective way for me.

- it was very informative and allowed the students to relate in a better way to the learning material.

- I liked it. You could actually concentrate on what was happening as he did the experiments. It also enabled you to ask questions.

MEATS UNIT

Hands-on Method

Responses to attitude questionnaire:

One or more things I liked about the hands-on method was:

- by doing something it helped me to remember it better; actually doing it made it easier for me to pay attention; <u>really</u> learned where individual pieces of meat came from and how all the pieces fit together to make a whole.

- it was fun and a great experience!; I don't think I'll have any other chance to experience this except in this lab; "franks" were fun to make!

- it was active; some labs were more interesting because we were allowed to participate; you were able to really get into the information you were being taught.

One or more things I disliked about the hands-on method was:

- it was long!; with so many people it took too long; we seldom left on time.

- it's cold in the cutting room!; it was extremely cold in the meats lab and hard to work with bundles of clothing; it's <u>sooo cold</u>!

- some experiences were missed when the lab groups worked on different things at the same time; there was not enough time to go over everything individually.

To improve the hands-on method, I would suggest that:

- shorter labs, but I'm not sure if this would be possible; instructor will do most of it as demonstration and only part of it for hands-on (shorter lab time).

- if the lab sections could be a little smaller?; provide additional educators to be on hand at each cutting table.

Overall, my feelings about the hands-on method are:

- it was easier learning with hands-on than trying to study on my own, this is the best way to learn; it does take longer, but first hand experience stays in the brain for a longer period of time and that saves time in the end for studying.

- cold; fun, but takes too long!; good experience; I'm glad I had the opportunity, possibly once in a lifetime experience.

MEATS UNIT

Videotaped Demonstration

Responses to attitude questionnaire:

One or more things I liked about the videotaped demonstration method was:

- it was shorter, lab moved along faster; there was no beating around the bush.

- it was easy to follow rather than listening to only a lecture; it was fairly descriptive and detailed; seeing everything in detail.

One or more things I disliked about the videotaped demonstration method was:

- put me to sleep; very boring; it is hard to sit (and listen) for that long of a time on a subject that doesn't interest you terribly; they were long and incredibly hard to sit through- not a good teaching tool.

- it was almost too futuristic; it was like being taught by a TV, also, when watching the hands-on (part of the tape) it gave a real feeling of being "left out".

- sometimes difficult to really see exactly what was going on. Also, harder to ask questions in the middle of the video.

To improve the videotaped demonstration method, I would suggest that:

- you don't use them in the future, too long to keep student's concentration; show shorter segments of tape with a couple of minutes discussion in between; make shorter, showing only the essential parts.

- review (highlight) important points after we've watched the tape.

Overall, my feelings about the videotaped demonstration method are:

- did not like it at all - at least for the section on meat, carcasses, etc.; negative.

- between hands-on and the videotape I liked the videotape; I liked it but it was easy to become disinterested in the video and let my mind wander onto other things; I like it if I do not have to be instructed by it <u>all</u> of the time; some times is alright.

- could do without; students may learn more from hands-on vs. trying to see what's on the TV screen; you don't get a real feel for cutting up a pig, you can only imagine what it would be like.

- it got boring at times simply sitting in a chair and watching the TV, but the same information was presented in a shorter time span which I liked.

MEATS UNIT

Live Demonstration

Responses to attitude questionnaire:

One or more things I liked about the live demonstration method was:

- we got to see the procedures in action; I really got to analyze and think about what was going on; interesting facts and information – visual, saw the correct way to do things.

- easier to ask questions, I felt like I was participating more; easier to follow along and pay attention.

One or more things I disliked about the live demonstration method was:

- too long to stand in a cooler; that we were watching but unable to write anything down; standing still in a cold room without doing anything was hard; coldness is distracting, you get fidgety standing for 3 hrs.

To improve the live demonstration method, I would suggest that:

- have observation room or chairs in refrigerator; warmer atmosphere.

- they should be shorter; some labs not quite so long – lose interest.

Overall, my feelings about the live demonstration method are:

- I liked it; I really enjoy it; it's much better than video; I didn't get dirty.

- I definitely prefer videotapes.

- not bad, pretty good part of lab – a lot better than video.

EGGS & POULTRY

Hands-on Method

Responses to attitude questionnaire:

One or more things I liked about the hands-on method was:

- I learned and remembered more when I actually did it myself; more interesting and easier to maintain attention; we were able to "get our hands dirty" and learn more with this method rather than just watching and not "feeling" the experience.

- so much easier to learn – I wasn't bored like with the other labs – It was fun!; more exciting than just watching; more fun... got to know other students better.

- practical; subjects were easier to understand because you saw it firsthand.

One or more things I disliked about the hands-on method was:

- too long; the pace; very time consuming; it was long but I know that can't be helped.

- too cold; standing up for 3 hrs. in a cold room without a break; we don't need to do all the stuff – it could be demonstrated once.

To improve the hands-on method, I would suggest that:

- only do one thing in the hands-on lab; only a couple of things be performed hands-on and the rest demonstrated; in some labs "hands-on" is unnecessary.

- speed things up; it be shortened; get right down to it.

Overall, my feelings about the hands-on method are:

- it was a very good learning experience; okay; good – best part of lab; it was my favorite – I learned a lot better; thumbs up!

- pretty good method of teaching but lab was too long; if the time could be reduced, it is by far the method I liked the most; too long but somewhat effective.

- not bad, better than demonstration and video.

- goes either way, but prefer demonstration; mixed – it was interesting, but I'll never do most of that stuff in my entire life.

EGGS & POULTRY

Videotape Demonstration

Responses to attitude questionnaire:

One or more things I liked about the videotaped demonstration method was:

- less time consuming; they were short and to the point; short and quick.

- it clearly demonstrated how to do things; it was more explicit; could see what was happening up close and was explained; accuracy and highlighted points.

- easier to see than the demonstration.

- it was easy to make up the lab.

One or more things I disliked about the videotaped demonstration method was:

- a lot dryer - especially after experiencing hands-on right before; didn't learn as much; they didn't keep my attention; it was hard to stay focused without an instructor in living flesh; what's the point when we can do it ourselves or watch someone in person and learn more?

- no real chance to ask questions during video tape; it is hard to concentrate on a screen and impossible to ask questions; I think this is completely unnecessary. Why watch Dr. Brekke on TV when he's sitting in the class? It is much more beneficial to be able to ask questions.

To improve the videotaped demonstration method, I would suggest that:

- better quality video taping; use better cameraman and get things into focus because it was hard to see things he was trying show us because it wasn't clear.

- they need to move quicker; the video be shorter and way more exciting - everyone basically fell asleep; liven it up.

- bigger T.V.; perhaps a larger screen and quieter room.

Overall, my feelings about the videotaped demonstration method are:

- I didn't like it; it was boring and I felt I didn't get as much out of it as I could with regular, live demo.; it wasn't an effective learning experience for me - I feel that hands-on and live demo. was easier for me to learn from; it was impersonal and could not ask questions during the demonstration.

- good method - I like it better than live demonstration, I thought it was effective - I was able to learn through it, satisfactory, good, okay, I liked the videotaped method the most out of all three methods.

EGGS AND POULTRY

Live Demonstration Method

Responses to attitude questionnaire:

One or more things I liked about the live demonstration method was:

- easy to understand what was going on; more practical to see first hand than on tape; everything was displayed well with explaining very vivid.

- the length; I got same understanding as hands-on, but it took less time; shorter than videos and I learned more than videos.

- it wasn't as boring as the video; I didn't have to actually do the work but I was able to see what was happening as it went along.

One or more things I disliked about the live demonstration method was:

- only so many people can get close enough; it was hard to see everything with such a large group; hard to see some demos (i.e. egg candling process).

- having to stand up for two hours straight; standing for such a long period.

- wasn't easy to take notes standing up so you miss a lot of information;

- students should be told to wear wool mittens, sox, and sweaters; the room was too cold to just be standing or sitting; too cold!!

To improve the live demonstration method, I would suggest that:

- chairs be placed in the room, to make it like an auditorium; sit up high and watch the demo below; students be able to sit through them because after awhile you concentrate on your feet hurting instead of the demonstration.

- have a better situation where students can take notes; review points and give notes after the demo; it's too difficult to watch and take notes at the same time.

Overall, my feelings about the live demonstration method are:

- it was more interesting than the videotape and kept my attention; this was my favorite out of the 3 methods; I felt I learned the most and it was interesting; I think it was the best of the 3 different teaching methods.

- I liked it the best because I could really see what was happening instead of just seeing the part the camera was focused on or getting messy; I was able to watch what was being done and stop and ask questions while it was happening, this is the best way to teach this lab; the hands-on seems to lose the students attention because it drags on for way too long. The film might be too brief. This seems to be the best learning or teaching device.

APPENDIX E

Laboratory Cost Comparisons and Summaries

Laboratory Cost Comparison
Laboratory 1
DAIRY: MILK COMPOSITION

	Hands-on - Wed. p.m.		Videotape - Thurs. a.m.		Live Demonstration - Thurs. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	4 hrs.	3 hrs.	1 hr. 45 min. incl. previewing tape (1 hr. 15 min.)	30 min.	1 hr.	1 hr. 30 min.
- T.A. incl. quiz prep. & grading[b]	3 hrs.	2 hrs. 30 min.	2 hrs.	1 hr. 30 min.	2 hrs.	1 hr. 30 min.
Supplies Procurement	30 min.		0		See hands-on	
Mileage	0		0		0	
Duration of Laboratory	2 hrs. 30 min.		2 hrs.		1 hr. 50 min.	
T.A. Meeting	30 min.		30 min.		30 min.	
Laboratory Clean-up						
- Instructor	30 min.	15 min.	15 min.	15 min.	15 min.	15 min.
- T.A.	0	15 min.	15 min.	15 min.	15 min.	15 min.
- Clean-up crew (time slip-$4.50 per hr.)	2 hrs. = $ 9.00	2 hrs. = $ 9.00	0 0	0 0	1 hr. = $ 4.50	1 hr. = $ 4.50
Supplies Cost	$ 6.65		0 (Not counting cost of videotape and production)		$ 1.00	
Total Time	11 hrs.	9 hrs. 30 min.	6 hrs. 45 min.	5 hrs.	5 hrs. 50 min.	6 hrs. 20 min.
Total Cost	$15.65	$15.65	0	0	$ 5.50	$ 5.50
In the instructor's opinion, using this particular laboratory teaching method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		Yes		No

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 2
DAIRY: MICROBIAL TESTING

	Hands-on - Wed. p.m.		Videotape - Thurs. a.m.		Live Demonstration - Thurs. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	3 hrs.	2 hrs. 30 min.	1 hr. 45 min. incl. previewing tape (1 hr. 15 min.)	30 min.	30 min.	30 min.
- T.A. incl. quiz prep. & grading[b]	3 hrs.	3 hrs.	2 hrs.	1 hr. 30 min.	1 hr. 30 min.	2 hrs.
Supplies Procurement	1 hr.		0		See hands-on	
Mileage	0		0		0	
Duration of Laboratory	2 hrs.		1 hr. 45 min.		2 hrs.	
T.A. Meeting	30 min.		30 min.		30 min.	
Laboratory Clean-up						
- Instructor	1 hr. 30 min.	1 hr.	0	0	30 min.	30 min.
- T.A.	30 min.	30 min.	0	0	30 min.	30 min.
- Clean-up crew	3 hrs. =	3 hrs. =	0	0	1 hr. =	1 hr. =
(time slip-$4.50 per hr.)	$13.50	$13.50	0	0	$ 4.50	$ 4.50
Supplies Cost	$29.50		0(Not counting cost of videotape and production)		$ 7.50	
Total Time	11 hrs. 30 min.	10 hrs. 30 min.	6 hrs.	4 hrs. 15 min.	5 hrs. 30 min.	7 hrs.
Total Cost	$43.00	$43.00	0	0	$12.00	$12.00
In the instructor's opinion, using this particular laboratory teaching method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		Yes		No

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 3
DAIRY: COUNTING MICROBES AND MICROBIAL STANDARDS

	Hands-on - Wed. p.m.		Videotape - Thurs. a.m.		Live Demonstration - Thurs. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	1 hr. 15 min.	1 hr. 30 min.	1 hr. 30 min. incl. previewing tape (1 hr. 15 min.)	30 min.	30 min.	30 min.
- T.A. incl. quiz prep. & grading[b]	2 hrs.	2 hrs.	2 hrs.	2 hrs.	1 hr. 30 min.	1 hr. 30 min.
Supplies Procurement	0		0		0	
Mileage	0		0		0	
Duration of Laboratory	2 hrs.		1 hr. 30 min.		1 hr. 30 min.	
T.A. Meeting	30 min.		30 min.		30 min.	
Laboratory Clean-up						
- Instructor	30 min.	30 min.	15 min.	15 min.	30 min.	30 min.
- T.A.	1 hr.	1 hr.	0	0	30 min.	30 min.
- Clean-up crew	0	0	0	0	0	0
(time slip-$4.50 per hr.)	0	0	0	0	0	0
Supplies Cost	0		0 (Not counting cost of videotape and production)		0	
Total Time	7 hrs. 15 min.	7 hr. 30 min.	5 hrs. 45 min.	4 hrs. 45 min.	5 hrs.	5 hrs.
Total Cost	0	0	0	0	0	0
In this instructor's opinion, using this particular laboratory teaching method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		Yes		Yes		Yes

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 4
DAIRY: SENSORY EVALUATION OF MILK, YOGURT, AND ICE CREAM

	Hands-on - Wed. p.m.		Videotape - Thurs. a.m.		Live Demonstration - Thurs. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	1 hr. 30 min.	1 hr.	2 hr. 45 min. incl. previewing tape (1 hr. 15 min.)	1 hr.	1 hr. 30 min.	1 hr.
- T.A. incl. quiz prep. & grading[b]	3 hrs. 30 min.	3 hrs.	3 hrs. 30 min.	3 hrs.	3 hrs.	2 hrs. 30 min.
Supplies Procurement	45 min.		See hands-on		See hands on	
Mileage	2 miles		See hands-on		See hands-on	
Duration of Laboratory	2 hrs. 30 min.		2 hrs. 30 min.		2 hrs. 30 min.	
T.A. Meeting	30 min.		30 min.		30 min.	
Laboratory Clean-up						
- Instructor	15 min.	15 min.	15 min.	15 min.	15 min.	15 min.
- T.A.	15 min.	15 min.	15 min.	15 min.	15 min.	15 min.
- Clean-up crew	0	0	0	0	0	0
(time slip-$4.50 per hr.)	0	0	0	0	0	0
Supplies Cost	$20.00		$20.00 (Not counting cost of videotape and production)		$20.00	
Total Time	9 hrs. 15 min.	8 hrs. 15 min.	9 hrs. 45 min.	8 hrs. 15 min.	8 hrs.	7 hrs. 45 min.
Total Cost	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00
In the instructor's opinion, using this particular laboratory teaching method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		No		No

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 5
MEATS: BASIC AREA CUTS

	Hands-on - Thurs. p.m.		Videotape - Wed. p.m.		Live Demonstration - Thurs. a.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	10 min.	1 hr. 30 min.	1 hr. 45 min. incl. previewing tape (1 hr. 30 min.)	15 min.	35 min. incl. thawing of meat cuts	2 hrs. incl. thawing
- T.A.	10 min.	1 hr.	0	0	35 min.	1 hr.
Quiz prep. & grading[b]	1 hr.	1 hr.	1 hr. 30 min.	1 hr. 30 min.	2 hrs.	1 hr. 30 min.
Supplies Procurement	0		0		0	
Mileage	0		0		0	
Duration of Laboratory	2 hr. 25 min.		1 hr. 35 min.		1 hr. 50 min.	
T.A. Meeting	40 min		40 min.		40 min.	
Laboratory Clean-up						
- Instructor	25 min.	25 min.	5 min.	5 min.	10 min.	25 min.
- T.A.	5 min.	15 min.	0	0	0	15 min.
- Clean-up crew (@ $5 per hr.)	30 min. = $ 2.50	30 min. = $ 2.50	0 0	0 0	See hands-on	30 min. = $ 2.50
Supplies Cost	$44.89		0 (Not counting cost of videotape and production)		$44.89	
Total Time	4 hrs. 55 min.	7 hrs. 15 min.	5 hrs. 35 min.	4 hrs. 5 min.	5 hrs. 50 min.	7 hrs. 40 min.
Total Cost	$47.39	$47.39	0	0	$44.89	$47.39
In the instructor's opinion, using this particular laboratory teaching method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		Probably Not		Yes		Probably Not - Depends on the T.A, knowledge and personality.

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 6
MEATS: WHOLESALE AND RETAIL CUTS

	Hands-on - Thurs. p.m.		Videotape - Wed. p.m.		Live Demonstration - Thurs. a.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
· Instructor	10 min., if don't wrap meat	1 hr. 30 min., if wrap meat	1 hr. 30 min. incl. previewing tape (1 hr. 15 min.)	15 min.	1 hr. 15 min. wrapped meat	1 hr. 15 min.
· T.A.	0	1 hr. 30 min.	5 min.	30 min.	2 hrs.	2 hrs. 15 min.
Quiz prep. & grading[b]	1 hr. 30 min.	1 hr. 30 min.	1 hr.	1 hr.	3 hrs.	3 hrs.
Supplies Procurement	See live demonstration		0		30 min.	
Mileage	See live demonstration		0		4 miles	
Duration of Laboratory	2 hrs. 50 min.		2 hrs. 5 min.		2 hrs. 20 min.	
T.A. Meeting	1 hr.		1 hr.		1 hr.	
Laboratory Clean-up						
· Instructor	25 min.	25 min.	10 min.	10 min.	10 min.	20 min.
· T.A.	5 min.	5 min.	5 min.	5 min.	5 min.	10 min.
· Clean-up crew (@ $5 per hr.)	30 min. = $ 2.50	30 min. = $ 2.50	0 0	0 0	See hands-on	30 min. = $ 2.50
Supplies Cost	$57.03		0 (Not counting cost of videotape and production)		$57.03	
Total Time	6 hrs.	9 hrs. 20 min.	5 hrs. 55 min.	5 hrs. 5 min.	10 hrs. 20 min.	10 hrs. 50 min.
Total Cost	$59.53	$59.53	0	0	$57.03	59.53
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		Depends on the T.A.		Yes		Depends on the T.A.

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 7
MEATS: PORK CARCASS CUTTING

	Hands-on - Thurs. p.m.		Videotape - Wed. p.m.		Live Demonstration - Thurs. a.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
· Instructor	25 min.	45 min.	1 hr. 45 min. incl. previewing tape (1 hr. 15 min.)	15 min.	10 min.	10 min.
· T.A.	20 min.	45 min.	0	0	30 min.	30 min.
Quiz prep. & grading[b]	1 hr. 5 min.	1 hr.	1 hr. 30 min.	1 hr. 30 min.	2 hrs.	2 hrs.
Supplies Procurement	See live demonstration		0		20 min.	
Mileage	See live demonstration		0		1 mile	
Duration of Laboratory	2 hrs. 50 min.		1 hr. 20 min.		1 hr. 35 min.	
T.A. Meeting	20 min.		20 min.		20 min.	
Laboratory Clean-up						
-Instructor	30 min. students wrapped	30 min.	5 min.	5 min.	1 hr. instructor and T.A. wrapped	1 hr.
-T.A.	30 min.	30 min.	0	0	20 min.	20 min.
-Clean-up crew (@ $5 per hr.)	4 hrs. = $20.00	4 hrs. = $20.00	0 0	0 0	See hands-on 0	3 hrs. = $15.00
Supplies Cost	$329.25		0 (Not counting cost of videotape and production)		$64.60	
Total Time	6 hrs.	7 hrs.	5 hrs.	3 hrs. 30 min.	6 hrs. 15 min.	6 hrs. 15 min.
Total Cost	$349.25	$349.25	0	0	$64.60	$79.60
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		Yes		Depends on the T.A.

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 8
MEATS: CURING AND SAUSAGE MANUFACTURE

	Hands-on - Thurs. p.m.		Videotape - Wed. p.m.		Live Demonstration - Thurs. a.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	30 min.	1 hr. 22 hrs - smokehouse 1 hr. 45 min. - packaging	1 hr. 35 min. incl. previewing tape (1 hr. 25 min.)	1 hr. 35 min.	1 hr.	1 hr. 22 hrs. - smokehouse 1 hr. 10 min. - packaging
- T.A.	1 hr. 30 min.	2 hrs.	10 min.	10 min.	2 hrs.	2 hrs. 30 min.
Quiz prep. & grading[b]	2 hrs.	2 hrs.	1 hr. 30 min.	1 hr. 30 min.	2 hrs.	2 hrs.
Supplies Procurement	See live demonstration		0		45 min.	
Mileage	See live demonstration		0		3 miles	
Duration of Laboratory	2 hrs. 45 min.		1 hr. 40 min.		2 hrs. 35 min.	
T.A. Meeting	20 min.		20 min.		20 min.	
Laboratory Clean-up						
- Instructor	1 hr. 10 min.	1 hr.	5 min.	5 min.	1 hr.	45 min.
- T.A.	40 min.	1 hr.	5 min.	5 min.	20 min.	45 min.
- Clean-up crew (@ $5 per hr.)	2 hrs. = $10.00	2 hrs. = $10.00	0 0	0 0	See hands-on	2 hrs. = $10.00
Supplies Cost	$31.90		0 (Not counting cost of videotape and production)		$25.65	
Total Time	32 hrs. 40 min.	34 hrs. 35 min.	5 hrs. 25 min.	5 hrs. 25 min.	33 hrs. 10 min.	33 hrs. 50 min.
Total Cost	$41.90	$41.90	0	0	$25.65	$35.65
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		Yes		No

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 9
EGGS AND POULTRY: INSTITUTIONAL MEAT CUTS

	Hands-on - Thurs. a.m.		Videotape - Thurs. p.m.		Live Demonstration - Wed. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
• Instructor	0	40 min.	1 hr. 55 min. incl. previewing tape (1 hr. 45 min.)	10 min.	2 hrs. 5 min.	2 hrs. 5 min.
• T.A.	55 min.	1 hr. 20 min.	5 min.	5 min.	1 hr. 15 min.	1 hr. 15 min.
Quiz prep. & grading[b]	2 hrs.	2 hrs.	1 hrs. 30 min.	1 hr. 30 min.	1 hr. 15 min.	1 hr. 15 min.
Supplies procurement	See live demonstration		0		20 min.	
Mileage	See live demonstration		0		4 miles	
Duration of Laboratory	3 hrs. 5 min.		2 hrs. 5 min.		2 hrs. 40 min.	
T.A. Meeting	20 min.		20 min.		20 min.	
Laboratory Clean-up						
• Instructor	15 min.	15 min.	10 min.	10 min.	40 min.	40 min.
• T.A.	15 min.	15 min.	5 min.	5 min.	25 min.	25 min.
• Clean-up crew (@ $5 per hr.)	1 hr. 30 min. = $ 7.50	1 hr. 30 min. = $ 7.50	0 0	0 0	1 hr. = $ 5.00	1 hr. = $ 5.00
Supplies Cost	$187.95		0 (Not counting cost of videotape and production)		$183.45	
Total Time	6 hrs. 50 min.	8 hrs. 15 min.	6 hrs. 10 min.	4 hrs. 25 min.	9 hrs.	9 hrs.
Total Cost	$1[illegible]5	$195.45	0	0	$188.45	$188.45
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		No		Yes		No

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 10
EGGS AND POULTRY: POULTRY PRODUCTS

	Hands-on - Thurs. a.m.		Videotape - Thurs. p.m.		Live Demonstration - Wed. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	5 min.	5 min.	1 hr. 20 min. incl. previewing tape (1 hr. 15 min.)	5 min.	45 min.	45 min.
- T.A.	1 hr.	1 hr.	0	0	45 min.	45 min.
Quiz prep. & grading[b]	2 hrs.	2 hrs.	50 min.	50 min.	2 hrs.	2 hrs.
Supplies procurement	See live demonstration		0		15 min.	
Mileage	See live demonstration		0		2 miles	
Duration of Laboratory	2 hrs. 50 min.		1 hr. 30 min.		1 hr. 35 min.	
T.A. Meeting	25 min.		25 min.		25 min.	
Laboratory Clean-up						
- Instructor	20 min.	20 min.	5 min.	5 min.	10 min.	10 min.
- T.A.	10 min.	10 min.	0	0	5 min.	5 min.
- Clean-up crew (@ $5 per hr.)	1 hr. 30 min. = $ 7.50	1 hr. 30 min. = $ 7.50	0	0	1 hr. = $ 5.00	30 min. = $ 2.50
Supplies Cost	$110.40		0 (Not counting cost of videotape and production)		$ 7.60	
Total Time	6 hrs. 50 min.	7 hrs. 5 min.	4 hrs. 10 min.	2 hrs. 55 min.	6 hrs.	6 hrs.
Total Cost	$117.90	$117.90	0	0	$12.60	$10.10
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?	No		Yes		Yes	

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 11
EGGS AND POULTRY: EGG QUALITY MEASUREMENT

	Hands-on - Thurs. a.m.		Videotape - Thurs. p.m.		Live Demonstration - Wed. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	10 min.	10 min.	1 hr. 25 min. incl. previewing tape (1 hr. 15 min.)	10 min.	1 hr. 15 min.	1 hr.
- T.A.	5 hrs. 45 min.	7 hrs. 45 min.	5 min.	5 min.	5 hrs. 15 min.	3 hrs. 30 min.
Quiz prep. & grading[b]	2 hrs.	2 hrs.	1 hr. 15 min.	1 hr. 15 min.	1 hr. 30 min.	1 hr. 30 min.
Supplies procurement	See live demonstration		0		1 hr.	
Mileage	See live demonstration		0		18 miles	
Duration of Laboratory	2 hrs. 50 min.		1 hr. 20 min.		1 hr. 50 min.	
T.A. Meeting	25 min.		25 min.		25 min.	
Laboratory Clean-up						
- Instructor	20 min.	20 min.	5 min.	5 min.	15 min.	30 min.
- T.A.	20 min.	20 min.	0	0	10 min.	30 min.
-Clean-up crew (@ $5 per hr.)	1 hr. = $ 5.00	1 hr. = $ 5.00	0 0	0 0	0 0	1 hr. = $ 5.00
Supplies Cost	$17.00		0 (Not counting cost of videotape and production)		$ 7.00	
Total Time	11 hrs. 50 min.	14 hrs. 50 min.	4 hrs. 35 min.	3 hrs. 20 min.	11 hrs. 40 min.	10 hrs. 15 min.
Total Cost	$22.00	$22.00	0	0	$ 7.00	$12.00
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		Yes		Yes		Yes

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

Laboratory Cost Comparison
Laboratory 12
EGGS AND POULTRY: PRODUCT EVALUATION

	Hands-on - Thurs. a.m.		Videotape - Thurs. p.m.		Live Demonstration - Wed. p.m.	
	Actual	Estimated[a]	Actual	Estimated[a]	Actual	Estimated[a]
Laboratory Set-up						
- Instructor	10 min.	1 hr. 45 min.	1 hr. 20 min. incl. previewing tape (1 hr.)	10 min.	1 hr. 45 min.	1 hr. 45 min.
- T.A.	45 min.	2 hrs.	0	10 min.	2 hrs. 30 min.	2 hrs. 30 min.
Quiz prep. & grading[b]	2 hrs.	2 hrs.	1 hr. 45 min.	1 hr. 45 min.	1 hr. 30 min.	1 hr. 30 min.
Supplies Procurement	See live demonstration		0		15 min.	
Mileage	See live demonstration		0		4 miles	
Duration of Laboratory	2 hrs. 25 min.		2 hrs. 30 min.		2 hrs.	
T.A. Meeting	25 min.		25 min.		25 min.	
Laboratory Clean-up						
- Instructor	10 min.	40 min.	10 min.	10 min.	40 min.	40 min.
- T.A.	0	30 min.	0	0	30 min.	30 min.
-Clean-up crew (@ $5 per hr.)	1 hr. = $ 5.00	1 hr. = $ 5.00	0 0	0 0	1 hr. = $ 5.00	1 hr. = $ 5.00
Supplies Cost	$20.00		0 (Not counting cost of videotape and production)		$20.00	
Total Time	5 hrs. 55 min.	10 hrs.	6 hrs. 10 min.	5 hrs. 10 min.	9 hrs. 35 min.	9 hrs. 35 min.
Total Cost	$25.00	$25.00	0	0	$25.00	$25.00
In the instructor's opinion, using this particular laboratory method, would it be possible for the laboratory T.A. (given training) to manage this laboratory independently?		Perhaps, if well trained.		Yes		Perhaps, with extensive training.

[a] Assuming no prior work had been done from a previous laboratory section.
[b] Would vary according to the T.A. In this case, each separate laboratory section had a different T.A.

SUMMARY

Estimated Total Gross[a] Cost Per Laboratory Section[b]

	Hands-on	Videotape	Live Demonstration
Laboratory 1	$ 15.65	$ 0.00	$ 5.50
Laboratory 2	$ 43.00	$ 0.00	$ 12.00
Laboratory 3	$ 0.00	$ 0.00	$ 0.00
Laboratory 4	$ 20.00	$ 20.00	$ 20.00
Dairy Unit	$ 78.65	$ 20.00	$ 37.50
Laboratory 5	$ 47.39	$ 0.00	$ 47.39
Laboratory 6	$ 59.53	$ 0.00	$ 59.53
Laboratory 7	$349.25	$ 0.00	$ 79.60
Laboratory 8	$ 41.90	$ 0.00	$ 35.65
Meats Unit	$498.07	$ 0.00	$222.67
Laboratory 9	$195.45	$ 0.00	$188.45
Laboratory 10	$117.90	$ 0.00	$ 10.10
Laboratory 11	$ 22.00	$ 0.00	$ 12.00
Laboratory 12	$ 25.00	$ 0.00	$ 25.00
Eggs & Poultry	$360.35	$ 0.00	$235.55
Totals	$937.07	$ 20.00	$495.22

Note. Costs for supplies and hiring of services only.
[a] Not deducting receipts from sale of meats products.
[b] Costs are for one laboratory section. FSHN 102 usually operates four sections per semester.

SUMMARY

Total Estimated Time Per Laboratory Section[a]

	Hands-on	Videotape	Live Demonstration
Laboratory 1	9 hrs. 30 min.	5 hrs.	6 hrs. 20 min.
Laboratory 2	10 hrs. 30 min.	4 hrs. 15 min.	7 hrs.
Laboratory 3	7 hrs. 30 min.	4 hrs. 45 min.	5 hrs.
Laboratory 4	8 hrs. 15 min.	8 hrs. 15 min.	7 hrs. 45 min.
Dairy Unit	35 hrs. 45 min.	22 hrs. 15 min.	26 hrs. 5 min.
Laboratory 5	7 hrs. 15 min.	4 hrs. 5 min.	7 hrs. 40 min.
Laboratory 6	9 hrs. 20 min.	5 hrs. 5 min.	10 hrs. 50 min.
Laboratory 7	7 hrs.	3 hrs. 30 min.	6 hrs. 15 min.
Laboratory 8	34 hrs. 35 min.	5 hrs. 25 min.	33 hrs. 50 min.
Meats Unit	58 hrs. 10 min.	18 hrs. 5 min.	58 hrs. 35 min.
Laboratory 9	8 hrs. 15 min.	4 hrs. 25 min.	9 hrs.
Laboratory 10	7 hrs. 5 min.	2 hrs. 55 min.	6 hrs.
Laboratory 11	14 hrs. 50 min.	3 hrs. 20 min.	10 hrs. 15 min.
Laboratory 12	10 hrs.	5 hrs. 10 min.	9 hrs. 35 min.
Eggs & Poultry	40 hrs. 10 min.	15 hrs. 50 min.	34 hrs. 50 min.
Totals	134 hrs. 5 min.	56 hrs. 10 min.	119 hrs. 30 min.

[a]Times are for one laboratory section. FSHN 102 usually operates four sections per semester.

SUMMARY

Total Actual Time Per Laboratory Section[a]

	Hands-on	Videotape	Live Demonstration
Laboratory 1	11 hrs.	6 hrs. 45 min.	5 hrs. 50 min.
Laboratory 2	11 hrs. 30 min.	6 hrs.	5 hrs. 30 min.
Laboratory 3	7 hrs. 15 min.	5 hrs. 45 min.	5 hrs.
Laboratory 4	9 hrs. 15 min.	9 hrs. 45 min.	8 hrs.
Dairy Unit	39 hrs.	28 hrs. 15 min.	24 hrs. 20 min.
Laboratory 5	4 hrs. 55 min.	5 hrs. 35 min.	5 hrs. 50 min.
Laboratory 6	6 hrs.	5 hrs. 55 min.	10 hrs. 20 min.
Laboratory 7	6 hrs.	5 hrs.	6 hrs. 15 min.
Laboratory 8	32 hrs. 40 min.	5 hrs. 25 min.	33 hrs. 10 min.
Meats Unit	49 hrs. 35 min.	21 hrs. 55 min.	55 hrs. 35 min.
Laboratory 9	6 hrs. 50 min.	6 hrs. 10 min.	9 hrs.
Laboratory 10	6 hrs. 50 min.	4 hrs. 10 min.	6 hrs.
Laboratory 11	11 hrs. 50 min.	4 hrs. 35 min.	11 hrs. 40 min.
Laboratory 12	5 hrs. 55 min.	6 hrs. 10 min.	9 hrs. 35 min.
Eggs & Poultry	31 hrs. 25 min.	21 hrs. 5 min.	36 hrs. 15 min.
Totals	120 hrs.	71 hrs. 15 min.	116 hrs. 10 min.

[a]Times are for one laboratory section. FSHN 102 usually operates four sections per semester.