ALTERNATIVE TEACHING-LEARNING METHODS FOR COLLEGE LEVEL UNDERGRADUATE ELEMENTARY FOOD PREPARATION LABORATORY INSTRUCTION

Dissertation for the Degree of Ph. D.

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ROSE MAE TINDALL

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ALTERNATIVE TEACHING-LEARNING METHODS FOR COLLEGE LEVEL UNDERGRADUATE ELEMENTARY FOOD PREPARATION LABORATORY INSTRUCTION

presented by

Rose Mae Tindall

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of the requirements for

Ph.D. degree in Human Nutrition

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ABSTRACT

ALTERNATIVE TEACHING-LEARNING METHODS FOR
COLLEGE LEVEL UNDERGRADUATE ELEMENTARY
FOOD PREPARATION LABORATORY INSTRUCTION

By

Rose Mae Tindall

The purpose of this research project was development of alternative instructional methods for the laboratory portion of an elementary food preparation course without qualitatively lessening student achievement normally produced by the current instructional method.

Student pre-enrollment requests denied for HNF 100 approximate 31.2 percent each term due to three interrelated factors: (a) course popularity vs. laboratory space limitations, (b) limitations with respect to qualified personnel to supervise and service the laboratory activities, and (c) the continuing rise in per student laboratory operational costs for food, supplies, equipment and instructional and non-instructional personnel. To ascertain whether this situation was unique or shared by other institutions, a mail questionnaire was designed to obtain information pertinent to current course offerings in elementary food preparation at 125 four-year, accredited universities and

colleges in the Continental United States. Usable responses were received from 80 percent of the institutions contacted.

The majority of elementary food preparation courses reported are designed for students with a variety of academic backgrounds. Of the reporting institutions, 81 percent have five or fewer faculty in the area of Foods, with each assigned the responsibility for more than one course per term in Foods/Food Science and Nutrition instructional programs.

The food preparation courses at the institutions surveyed are taught each term of the academic year, have a common lecture for all enrollees, determine lecture enrollment by the laboratory spaces available, and have an average of three laboratory sections per term (usually oversubscribed by one or two students per section).

Male enrollment for most courses is very small. Instruction is predominately by female faculty members assisted primarily by female undergraduate or graduate students. Instructor-demonstrations of product preparations and discussion of product evaluations followed by student preparation and evaluation of selected products is the laboratory instructional method most commonly used.

In this study, the laboratory subject matter for an elementary food preparation course was divided into six Units of Study: (A) Laboratory Orientation; (B) Biscuits,

Yeast Rolls, Fats and Oils, Cream Puffs, Pie Pastry and Butter Type Cakes; (C) Starches, Cereals, Milk and Cheese, Eggs, Custards and Egg Foam Products; (D) Meats, Poultry and Fish; (E) Vegetables, Fruits, Salads, Mayonnaise Dressing and Gelatin Products; and (F) Laboratory Final Examination. Units A and F were taught by the Control Method only. The Control and Experimental Methods I (instructor demonstration and student evaluation of instructor prepared products), II (combination of Experimental Methods I and III), and III (student independent study) were applied to Units B, C, D and E. A total of 153 students participated in the study with enrollments for four laboratory sections Winter and Spring Terms, 1975 totaling 75 and 78 students, respectively. For the Latin Square design for Units B, C, D and E, every instructional method was applied to each laboratory unit of study with each laboratory section receiving every laboratory instructional method once.

Student learning and performance on laboratory exercises and activities were evaluated by achievement on written product summary outlines, product evaluations, laboratory unit tests and a final laboratory examination. Student attitudes were assessed by four laboratory unit reactionnaires and a final laboratory evaluation. Records of student, instructional and non-instructional time involvement and costs were summarized and analyzed. Costs

for food supplies per laboratory unit of instruction were also determined. Student's t was used for analysis of pre-test and product evaluation scores while product summary outlines, laboratory unit tests and laboratory final examination scores were analyzed by one-way ANOVA and planned comparisons. Responses on laboratory study unit reactionnaires were weighted one to five (least to most) and the mean extent of favorableness per category of interest was reported. Other comparisons were based on mean values or tabulated opinion results.

Student composition of all experimental laboratory sections was shown comparable. No significant differences in achievement were noted between the control and experimental instructional methods for the product summary outlines of Units B, C and E. Experimental Method III produced higher achievement than the Control Method for Laboratory Unit D. For Units C, D and E, Experimental Method I mean scores on product evaluations were significantly higher than the Control Method mean scores. Laboratory Unit Tests I, II, III and IV were shown reliable (KR_{20}) and the examination content validated by subject matter experts. Experimental Method III was best for achievement on Laboratory Unit Test II. No other differences were found between the Control and the experimental methods on Laboratory Unit Tests I, III, or IV. Achievement on the laboratory final examination did not

differ significantly among four laboratory sections (Winter or Spring) taught by four different instructional sequences.

Student attitudinal information demonstrated the greatest preference for instruction by the Control Method (student preparation and evaluation of student-prepared products) with supplementary instruction by instructor demonstrations and the independent study materials developed for Experimental Methods II and III.

Experimental Methods II and III decreased time required of the instructional staff by 50 to 75 percent of the time required by the Control Method, and non-instructional staff time by 66 to 100 percent.

Compared to the Control Method, Experimental Methods I, II and III decreased the calculated food costs per student by approximately 50, 75 and 90 percent, respectively. Instructional and non-instructional staff costs can be decreased by Experimental Methods II and III due to reductions in the number of Graduate Teaching Assistants and non-instructional staff services required.

ALTERNATIVE TEACHING-LEARNING METHODS FOR COLLEGE LEVEL UNDERGRADUATE ELEMENTARY FOOD PREPARATION LABORATORY INSTRUCTION

By

Rose Mae Tindall

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Food Science and Human Nutrition

1976

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ROSE MAE TINDALL

1976

DEDICATION

To:

My students--

past, present, and future--

with gratitude.

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CHAPTER I

INTRODUCTION

Irrespective of educational program level, the primary responsibility of all persons associated with teaching-learning systems is to develop and use instructional strategies which effectively service the needs of learners and are operationally feasible with the human, material and financial resources available. Although significantly more costly per student, in certain courses of study it is generally believed that to achieve maximum learning effectiveness the study of theoretical concepts should be accompanied by opportunities for concept application through student performance activities in instructor-supervised settings. However, because of increasing societal demand for education beyond the high school level and continuously rising operational costs, institutions of higher learning are being forced to reevaluate the use of their resources in relation to the numbers of students to be served. The development of alternative instructional strategies which will permit the handling of larger numbers of students in laboratory settings without adversely

affecting the quality of student learning is of immediate concern to both educators and students.

During her years of advanced graduate study the author served as a graduate teaching assistant in an undergraduate course in food preparation in which all students participate in the preparation of the food products studied at each laboratory session. Professional interest in teaching undergraduate students in foods and personal involvement with the operational problems of providing applied learning experiences for large numbers of students under this laboratory instructional plan provided the incentive to investigate the merits of alternate instructional strategies for applied learning experiences in foods courses.

Nature of the Problem

This investigation concerned the development, testing and evaluation of the learning effectiveness of four different instructional approaches for the laboratory portion of the four-credit undergraduate course Elementary Food Preparation (HNF 100) given by the Department of Food Science and Human Nutrition in the College of Human Ecology at Michigan State University. Descriptively, this course emphasizes the following aspects of study:

> Composition and properties of food related to quality characteristics; methods of preparation, evaluation of quality and use of selected foods (1976 MSU Description of Courses, p. A-71).

HNF 100 is open to all students in the University and is offered Fall, Winter and Spring terms of each academic year. Because of the physical design restrictions of the available laboratory areas, enrollment is generally restricted to 120 students per term (six laboratory sections of 20 students each). Under the present course instructional plan for the applied laboratory experiences (two 2-hour sessions/week), 31.20 percent of the student preenrollment requests must be denied each term. The continuing inability of the Department to satisfy student enrollment requests for this course is caused by three interrelated situational factors: (a) course popularity versus laboratory space limitations, (b) limitations with respect to qualified personnel to supervise and service the laboratory activities, and (c) the continuing rise in per student laboratory operational costs for food, supplies, equipment, and instructional and non-instructional personnel.

Course Popularity versus Laboratory Space

Although HNF 100 is intended to service all interested University students, in actual practice it is impossible to do so. The three food laboratory facilities designated for use for this course must also service the needs of other foods courses in the department each term.

From a practical standpoint, priority of enrollment must be given to undergraduate students for whom HNF 100 is a required course for their selected major area of study. On the average, this imposes allocation of about 90 (75%) of the 120 available laboratory spaces to students majoring in Hotel, Restaurant and Institutional Management in the College of Business and students majoring in Home Economics Education and in Consumer-Community Services in the College of Human Ecology. The increasing discontent among students from other University majors who are continually denied admission to HNF 100 is of genuine concern to University administrators at all levels.

Personnel Currently Available

Instructional staff. Each term the faculty person responsible for the course prepares and delivers all of the lectures and, in addition, supervises two of the six laboratory sections. Instruction for the four remaining laboratory sections is assigned to graduate teaching assistants (one laboratory section per graduate assistant). Since most of the graduate teaching assistants assigned laboratory instructional duties for HNF 100 are involved for relatively few consecutive terms, recruitment and training of laboratory instructional personnel for this course are not only continuous, difficult and time consuming tasks, but costly as well.

Non-instructional support staff. The Food Science and Human Nutrition Department employs two full-time Laboratory Aides to assist in the operation of all foods courses. Approximately 60 percent of their time is devoted to HNF 100 for 12 laboratory set-ups per week. Laboratory set-ups involve assembling and organizing all food, supplies and equipment for each laboratory session.

In addition, these two employees are responsible for providing eight other services for all foods courses offered in the Department.

1. Purchase and storage of all food supplies.
2. Pre-preparation of some of the food items needed for particular student learning assignments.
3. Assembly and organization of materials for instructor demonstrations.
4. Post-laboratory clean-up after each laboratory session.
5. General care of all large and small equipment.
6. Care of general laboratory linen.
7. Food, supply and equipment inventories.
8. Major laboratory cleaning at the end of each term.

In recent terms, additional student work-study hours (8 to 10 per week) have been required to assist in the clean-up of the laboratories and to return excess food, supplies and equipment to their respective storage areas. Under the current instructional plan, any increases in the number of HNF 100 laboratory sections offered would require commensurate

increases in non-instructional staff time to service the operational needs adequately.

Laboratory Operational Costs

Although the operation of instructional laboratories for foods courses has always been recognized as an expensive practice, the continuing rapid rise in laboratory material costs has intensified the concern of educators charged with the responsibility of managing department resources to meet student needs. Prior to Fall Term 1973, all foods, supplies and equipment purchases for all foods courses in the Department of Food Science and Human Nutrition were accounted for annually but only in terms of total material costs for all courses offered. These limited data provided little basis for responsible administrative decisions concerning feasible budgetary adjustments in these times of national economic stress.

Beginning Fall Term 1973, however, operational cost data for all departmental food courses were detailed by course. In addition, the material costs per student for HNF 100 were calculated at the end of each academic term. From these data it appeared that, under the present laboratory instructional plan, expansion of the number of laboratory sections offered per term to accommodate increased student demand for HNF 100 is impractical. Exploration of alternate means of providing applied learning experiences

in this foods course appears to be a more likely approach for resolving the problem.

Need for the Study

Traditionally, college level food preparation laboratories have employed the design of multiple student units or work areas where each student, working independently or as a member of a small group, has the opportunity to learn and practice manipulative techniques under the direct supervision of a qualified instructor. Few attempts have been made to devise new or modified laboratory instructional methods that might be applied to segments of the laboratory work or to the entire sequence of laboratory instruction without qualitatively lessening student achievement.

The need to investigate the relative effectiveness of alternate laboratory instructional methods for the course in elementary food preparation offered at Michigan State University is critical. It is conceivable that findings from this study could provide valuable direction for devising ways to:

a. reduce the number of student enrollment requests which currently must be denied;

b. permit expansion of the number of laboratory sections offered without parallel increases in required instructional and non-instructional support staff; and

c. manage rising laboratory operational costs more effectively.

CHAPTER II

REVIEW OF LITERATURE

This review is divided into three aspects pertinent to the study under consideration. First are articles that relate the developments in laboratory instructional methods for college level food preparation courses. The second part of the review reports on changes in instructional methods in other types of college level courses. The final segment of the chapter describes a few general aspects of instructional development and effective teaching along with available techniques and materials for designing alternate methods for student learning.

Developments and Diversity in Approaches to the Instruction of College Level Food Preparation Laboratories

A search of the literature for the period 1963-1976 has revealed few studies related to the development of innovative laboratory instructional methods for college level elementary food preparation courses. This scarcity of information can be interpreted from two different perspectives: (1) innovative instructional techniques are being explored, developed and evaluated, but findings are not yet

reported, or (2) traditional methods of laboratory instruction are continuing to be used with few, if any, deviations.

One of the first indicators of change in foods curricula reported in the literature of the mid-1960s is illustrated by two separate attempts to establish criteria for evaluating the competency of college students in the basic skills of food preparation prior to enrollment in elementary foods courses. A multiple choice placement test constructed by Lee (1965) was designed to measure a student's ability to use foods vocabulary in the practical application of principles. Appropriate level food courses were recommended on the basis of the test scores obtained. This researcher found that laboratory grades did not correlate well with the student's stated experience and suggested that performance tests might be a better predictor with the limitation that performance tests are time consuming and require accurate grading which is difficult to obtain when grading subjectively. Lee's best recommendation suggested that principles, procedures (including ingredient functions) and evaluations be stressed instead of only emphasizing the production of high quality finished products.

Steelman and Barbour (1965) emphasized the need for food laboratory pre-tests based on the objectives and generalizations of course content in order to delete topics

which add little to knowledge already gained through previous experiences. Objectivity, validity and reliability were the main goals desired in the development of the laboratory pre-test designed in two sections: written and laboratory practicum. These co-workers devised the multiple choice test so that students were given problems to solve in relation to selection of equipment, recognition of standard products, identification of correct methods for critical steps in procedures, selection of food items for specific meal occasions and recognition of errors in a place setting. The test was found to discriminate at a level of 77 percent with a reliability index of 0.83. This attempt at systematic evaluation of competence of entering students demonstrated much potential but follow-up studies or similar studies by other authors for food preparation courses are not prevalent in the literature.

Traditionally, food preparation laboratories have employed the design of multiple student units or work areas where each student, working independently or as a member of a small group, has the opportunity to learn and practice manipulative techniques under the direct supervision of a qualified instructor. Rising costs of instructional materials (food, supplies, equipment) and increases in student enrollment have necessitated limitations on actual student participation in the preparation of food products in

the laboratory. According to Medved and Sullivan (1967), attempts to at least partially cope with these situational factors have led to greater instructional emphasis on the "principles" of food preparation and the identification of "quality characteristics" associated with typical and atypical finished products.

Coleman (1966) and Trotter (1961) suggested that one alternative laboratory instructional method might be substitution of instructor demonstrations of product preparation for student activity in the foods laboratory. Research findings in both studies showed no significant difference in student achievement between traditional and instructor demonstration methods, but Trotter reported that students taught by the demonstration method expressed a lack of confidence in their manipulative skills.

Co-workers Keiser and Sullivan (1966), Medved and Sullivan (1967), and Saneholtz and Keiser (1964) were among the first to combine instructional television demonstrations and student preparation of selected products. In this approach, videotaped demonstrations were used at the beginning of a laboratory session and then followed by student preparation of similar products. According to Keiser and Sullivan (1966), the method of televised demonstrations gave the instructor greater freedom from laboratory routine, permitted more efficient and economic scheduling of classes

and provided the students with experience in food handling techniques. These same investigators observed that if laboratory preparation was carried out without initial television instruction, more than twice the time was required by students assigned to multiple units to perform non-productive activities, such as organization of materials for product preparation and clean-up. The extreme close-up photography and the live, continuous, hand-modeled demonstrations were rated more interesting and realistic by the viewers than were photographs, film strips, or artistic visuals. When students were asked on a course evaluation sheet if they favored deletion of television instruction to provide additional time for laboratory experience, a majority supported retention of the demonstration tapes. Although the method produced a positive and favorable effect on student achievement and attitude, the techniques of food preparation and food handling under television lights presented many problems that detracted from the presentation.

Instructional television offers unique advantages for classroom instruction but if used alone with no subsequent preparation laboratories, student attitudes, attentiveness and self-confidence in manipulative skills often are lower than those expressed by students involved in actual laboratory preparation exercises (Trotter, 1961).

Individual differences in skills and experience in food preparation brought by students to the average beginning college level foods course are great. This motivating force has inspired some workers to investigate the advantages and disadvantages of self-instruction laboratories to replace or supplement the laboratory instructor demonstrations and explanations. Short et al. (1969) subdivided a beginning foods course into subject matter units of study with a pre-test for each unit. Students who answered eight out of ten pre-test questions correctly for any subject matter unit proceeded directly to the foods laboratory for preparation of appropriate products. Students receiving lower scores reviewed the self-instruction materials until post-test scores of eight out of ten or better were obtained before proceeding to the foods laboratory. The investigators indicated that the self-instruction laboratory method was also used by students who missed scheduled classes and by those in more advanced courses who needed or wanted review.

Another researcher, Tope (1969), developed a self-instruction approach to teaching introductory food preparation laboratories with audio-tutorial materials. The audio tapes included supplementary subject matter discussion and instructions for the exercises and experiments to be performed in the laboratory. The data showed that students in the audio-tutorial group

performed as well as those in the traditional sections and spent no more time on the average in the audio-tutorial laboratory than their counterparts did in the traditional laboratory.

As indicated previously, the availability of literature concerning new or innovative instructional methods for elementary food preparation laboratories is almost non-existent. To substantiate this point and give insight into curricula in Home Economics, consider the findings of a survey conducted by Johnson and Swope (1972) and reported in the Journal of Home Economics. These investigators used current catalogs and a questionnaire addressed to 108 Home Economics Administrators of state, land grant, denominational, private and municipal universities and/or colleges to obtain information descriptive of home economics course offerings. Data from the respondents demonstrated that of those institutions surveyed, more were traditional and static than fluid or futuristic with respect to curriculum design. After reviewing course offerings, course content descriptions and individual program requirements, the authors reported little evidence of curricular innovation in terms of new courses or new methods and techniques. On the basis of these findings, Johnson and Swope (1972) stressed a need for greater flexibility in general program requirements, more opportunity for independent

study, more exposure to newer methods of teaching and a greater use of individualized programs in home economics curricula.

Changes in College Level Instructional Methods in Other Types of Courses

The Hale Committee report on University Teaching Methods (1964) as discussed by Maddox (1970) was a descriptive survey of current practice and of the opinions of staff and students. The Committee found that the average weekly hours of instruction by Faculty and type of teaching period were:

Type of Teaching Period	Arts	Pure Science	Applied Science
Lectures	6.8	8.3	10.7
Written exercise classes	0.4	0.3	1.1
Practicals	0.5	7.7	6.9
Tutorials and seminars	2.4	1.0	0.9

This chart illustrates that Art Faculties use mainly lecture and discussion methods, accompanied presumably by discursive reading; that the Sciences give more lectures, practicals and laboratory periods, and rely much less on discussion lessons. In the Applied Sciences considerable time is given to supervised work periods or "problem" sessions in which students work examples and exercises.

Many areas of study are and have been experimenting with alternative instructional methods or modifications of methods in attempts to broaden the scope of possibilities for increased or facilitated student achievement. The general trend in many instances appears to be development and use of instructional techniques specifically designed to accommodate large student numbers while still maintaining as much student-instructor interaction as possible. The examples to follow are intended to selectively describe these instructional trends.

Sisler (1970) adapted an audio-tutorial instructional system to a beginning course in clothing construction at Oklahoma State University. What originally had been a three-hour, lecture-discussion course, was revised to consist of one weekly lecture, one quiz session and independent study time of two to three hours per week. More than 200 students were registered for this course. Results from a course evaluation sheet completed by 155 students indicated that 75 percent of the students thought they could have learned the information in the course on their own in the audio-tutorial laboratory if both the quiz and lecture sessions had been eliminated. Sisler commented that consideration was being given to developing the course into a completely independent study program where students who already knew some of the material would be permitted to

"test-out" of those units and complete the remaining units in a shorter period of time.

A similar methodology that is gaining rather wide acceptance is that of programmed instruction, especially since programmed materials are becoming commercially available. Bartz and Darby (1965) at Purdue University compared supervised and non-supervised programmed instruction as used in an intermediate algebra course. Non-supervised programmed instruction, supervised programmed instruction and total instruction by a faculty member produced no significant differences in student achievement. However, attitudes expressed by the non-supervised programmed instruction students were significantly less favorable than those expressed by students of the other two methods of instruction. The non-supervised programmed instruction group also completed less total material. These researchers concluded that programmed texts were effective in the instruction of algebra provided the student's study was supervised.

While a wealth of data exists to attest to the general effectiveness of learning from programmed instructional materials (Bartz and Darby, 1965; Tobias, 1969; Branson, 1970; Anderson, 1971; Iwanicki, 1975), little attention has been given to the problem of incorporating these techniques into existing educational systems and practices. This is

particularly true at the college level. Where the few available programs have been tried, students have been allowed to work on them whenever they wished, sometimes as an adjunct to the class meeting and sometimes in lieu of class meetings. Whichever the case, material presented in the programmed format is reported to have been learned to the same level of proficiency as the material presented in the traditional manner (Bartz and Darby, 1965).

Due to increasing costs of instruction and larger student enrollments, courses that in the past have depended on individual laboratory instruction techniques are, of necessity, now exploring other possibilities. Until the introduction of audio-tutorial programs, demonstration methods were the only alternative solution.

Bradley (1965) examined lecture-demonstration versus individual laboratory work in a general education natural science course. All demonstrations were performed by instructors with little or no student participation. The experimental groups were composed of 80 to 82 students whereas the standard method laboratories contained 35 to 38. The experimental group had the option of going to the laboratory during the second hour of class instruction to examine, or rerun on their own, the experiment that had been previously demonstrated. Approximately one-fourth of the students availed themselves of this opportunity.

On the basis of the data analyzed, Bradley concluded that the lecture-demonstration method and the individual laboratory method were equally effective means of teaching that particular natural science course. He found no experimental evidence of interaction between methods, sexes, above median on the CQT-T group and below median on the CQT-T group, and those having had previous college laboratory science courses and those who had no previous laboratory science courses. The seeming lack of difference in the two methods may, however, mask their true significance. Since the lecture-demonstration method, which held its own with the individual laboratory method as a means to immediate learning, made possible a considerable savings in apparatus, physical plant and instructor time, this may offset any advantages of the individual laboratory method not revealed through the data collected and analyzed.

Perhaps the most promising and currently most explored area of instructional methodology is that of self-paced study (independent study or student self-instruction). Limitations of plans for individualizing instruction (time, expense, maintenance, etc.) have often dictated that programs be less elaborate than desired. As early as 1969, Shear and Ray suggested that individual learning packages have been most feasible in this respect. When basic concepts are presented in such a manner that the individual

may proceed at his own pace and learn in his own style by selecting from among resource materials and activities, positive results are achieved. This technique has been used for instruction in consumer education (Shear and Ray, 1969), general education science courses (Jones, 1968; Kapfer and Swenson, 1968), industrial arts (Spence, 1964), and business education (Clayton and Moles, 1971).

Audio-tutorial, programmed and/or computer-assisted instruction were also suggested by Shear and Ray (1969) as flexible possibilities for adaptation to existing course materials. Subject matter areas where methods of student self-instruction have been used are quite diverse: pharmacology (Green and Sykes, 1962); psychology (Oakes, 1961); mathematics (Bartz and Darby, 1965); food service management (Acacio, 1972; Tanzman, 1973); human medicine (Manning, Abrachamson and Dennis, 1968); and veterinary pathology (Appleby and Poland, 1968). In the past, many uses of media have been of a marginal character, but now the trend is accelerating toward the indispensability of media in the teaching-learning process (Stepp, 1968).

General Aspects of Instructional Development, Effective Teaching and Available Techniques and Materials for Designing Alternate Methods for Student Learning

The task of any educator, as stated by Krathwohl (1965), is to help the student learn new or changed behaviors and determine where and when they are appropriate. No matter which method of instruction is chosen, the beginning approach to curriculum building should be the formulation of operational definitions of instructional goals in terms of overt behavior. These objectives may have several levels of specificity depending upon their intended use. Krathwohl defines these levels of specificity as:

1. Quite broad and general statements useful for the laying out of types of courses and areas to be covered.
2. Behavioral Objectives--These analyze broad goals into more specific ones, directly stating expected outcomes of instructional units.
3. Objectives of specific lesson plans, the sequence of goals in these plans, and the level of achievement required for each goal.

Gagne (1963), Mager (1962), Hartley (1971), Emmer (1971) and Wilkens (1973) also advocate the writing of educational objectives, especially for student self-instruction programs. The views of these authors suggest that specific statements of course objectives facilitate the conversion of ideas into instructional materials

so that instruction and evaluation can be focused upon applicability of subject matter and not subject matter content itself.

An even more detailed procedure for instructional development is that outlined by Cavert in the Proceedings of the 1972 Lincoln Leadership Conference on Instructional Design and summarized as follows:

1. Determine the elements already present and those variables to be taught.
2. Select the target population.
3. Analyze learner needs and expectations.
4. Sequence the instruction in a step-by-step strategy that describes progressive levels of responses and then specify the objectives that will evidence learning gains.
5. Write objectives so that they reflect all performance levels in the sequence leading toward the goal of developing skills, increasing knowledge, or formulating values.
6. Look at each objective individually to develop a structure for the experience that is compatible with the approach and sequence.
7. Implement the program.
8. Measure the responses.
9. Repeat the work to obtain consistent results (reliability) when used under appropriate conditions for a specific target group to seek validation.

Whichever instructional approach is used, the end requirement is the same. If a program's results cannot be validated to evidence specific learning gains, benefits

or merits, the program generally will not receive support for its institution into the curriculum.

Effective teaching involves more than just implementation of an instructional method or approach. Teaching, according to Lundstedt (1966), is basically communication between two or more people where the teacher hopes to convey to the learner an idea or feeling about a subject. The author stresses continuity, sequence and integration as the specific tools to communicate effectively. Baird (1973) stipulates that the characteristic ways an instructor teaches his classes can have important consequences for his students' learning, satisfaction and development. His teaching style reflects his educational values as well as the goals he hopes his students will attain. In order to measure the effectiveness of teacher styles Baird (1973) devised a descriptive framework with six dimensions:

1. Didactic: Emphasized specific, detailed knowledge of facts and comprehensive coverage of the field.

2. Generalist: Concerned with helping students apply the ideas and facts of the field to their lives.

3. Researcher Approach: Places importance on the interpretation and analysis of information and the current topics and disputes in the field.

4. Relevancy of student responses to classroom activities.

5. Relative clarity or ambiguity of teachers' expectations.

6. Affective rewards given by instructors to their students (Friendliness, warmth, support, etc.).

Tests, opinionnaires and rating sheets were used to obtain data from 2,670 students from varied disciplines at two-year colleges on these six dimensions. The generalist dimension received the highest ratings with the researcher approach second in significance. On the other end of the continuum, ambiguity showed a negative relationship to effective teaching and resultant student achievement and attitude. Many of Baird's (1973) dimensions of teaching styles are the same as those Dressel (1966) applied to effective student learning principles. Dressel (1966) and Tyler (1958) stress motivation, relevance, recognition of importance, satisfaction, learning and achievement as directly related to teaching styles and their effectiveness.

The range of possibilities for techniques and materials to be used in instruction are endless. The more traditional forms (lecture, discussion and practical laboratory exercises) are most widespread in use (Costin, 1972; Zahorik, 1973). Research in the use of instructional media to supplement class instruction or to totally replace it has been pursued rigorously since the early 1900s (Allen, 1971). Instructional television, programmed instruction,

and self-instruction modules (slide-tape presentations) are lauded as having great potential.

Pinsky (1971), Chief Economist for Market Retrieval, Inc., states that business has used audio-visual instruction for many years as a means to expand industry, but that higher education has been somewhat slow to respond to these same innovations. One reason for this is that audio-visual equipment budgets are extremely vulnerable to cyclical shifts in the availability of educational funding. Pinsky predicts a shift from equipment purchases to higher budgets for materials and supplies for use with equipment previously purchased and in use through resource centers. Furthermore, Pinsky believes that an increasingly important place for audio-visual techniques and television in higher education is virtually assured if the trends to more independent study, credit by exam, external degree programs and universities without walls continue. The most popular items purchased by audio-visual centers and educators, as listed by Pinsky, are:

1. Videotapes, commercial productions and blank tapes
2. Microfilm and Microfiche
3. Transparencies and Masters
4. Phonograph records
5. Audio-tapes (Reel to Reel)
6. Audio tapes (Cartridge and Cassette)

7. 8 mm films (Sound)
8. 8 mm films (Silent)
9. Filmstrips
10. Slides

According to Pinsky, the most widespread and probably fastest growing coordinated use of audio-visual devices is found in the variations of the audio-tutorial system, originated at Purdue University in 1961 by Samuel Postlewait of the Biology Department. This system has spread to more than 200 institutions in the United States, Canada, England and Australia.

Streeter (1971) suggests that three comparatively new developments appear to provide the means to break the lock-step system of education. These new advances are the digital computer, learning laboratories and programmed instruction with a much greater future for the computer as an integrative device (simulation, problem solving, drill and practice) and less as an information presenter. Streeter also believes that automated, multi-media, self-instructional systems will make it possible for instructors to present materials in several formats in order to meet the needs of many different learning styles.

Summary

A search of the literature has revealed few studies related to the development of innovative laboratory instructional methods for college level elementary food preparation courses. A need has been stated for the use of placement and pre-tests, but few investigators have pursued this line of research. The predominant efforts to revise the traditional laboratory instructional methods have been through the use of televised demonstrations, actual instructor demonstrations in the laboratory, or self-instructional units of study.

Other university courses appear to stress these same traditional methods of lecture, discussion and practical laboratory exercises. Significantly more research in instructional methods has been conducted in the pure sciences than in other areas including food preparation. Some of these efforts include programmed instruction, instructional television, computer-assisted study and independent or self-instruction programs.

Objectives, instrumental development systems, teaching styles and student variables are important components of effective teaching for maximum student learning and achievement. All of these are the responsibility of the instructor to facilitate and guide the acquisition of

knowledge. Techniques and materials used in instruction vary in effectiveness, but appropriate applications make the instructor's tasks easier and produce far greater rewards and satisfaction for the student and the instructor. The use of audio-visual materials has become increasingly important to the efforts of most educators.

CHAPTER III

CHARACTERISTICS OF COLLEGE LEVEL COURSE OFFERINGS IN ELEMENTARY FOOD PREPARATION

As noted in Chapter I, the Food Science and Human Nutrition Department, College of Human Ecology, Michigan State University, has been experiencing student enrollment requests for the course in Elementary Food Preparation (HNF 100) that each term exceed the available laboratory space and instructional personnel. In order to establish whether this situation was unique or one shared by other institutions, a mail questionnaire was designed to obtain information pertinent to current course offerings in elementary food preparation at 125 four-year, accredited universities and colleges in the Continental United States.[1] A copy of the questionnaire and a list of the institutions which supplied usable data are included in Appendix A. This preliminary survey was conducted in January 1974 to insure that any instructional techniques developed for use in HNF 100 would be applicable or capable of being adapted

[1]Sources of initial mailing list: Accredited Institutions of Higher Education (Washington, D.C.: American Council on Education, 1972-73); and The College Handbook (New York: College Entrance Examination Board, 1972).

to similar teaching-learning situations involving instruction in basic skills and concepts of food preparation. Of the 125 institutions contacted, 111 returned the questionnaires. Of the 111 returns (88.8%), only 100 (90.1%) were usable for data analysis. This considerable response demonstrates in itself that interest in the problem extends to a broader populace than Michigan State University.

The major findings of the survey are presented in the following order:

1. Institutional Organization Structure,
2. Lecture and Laboratory Enrollment Data,
3. Instructional and Non-Instructional Staff,
4. Academic Pre-Requisites and Typical Student Composition,
5. Laboratory Instructional Methods, and
6. Instructional Texts.

Institutional Organization Structure

In this category information was requested on items that initially influence the structural framework of a course such as departmental organization or instructional term basis (see Part A, Survey Questionnaire, Appendix A).

Twenty of the 100 institutions which supplied usable data listed more than one elementary food preparation course. In all 20 cases, one elementary food preparation course was

designed for Foods and/or Home Economics Education Majors and a second course structured for other majors. Lecture credit was separated from laboratory credit in only 17 of the 125 courses reported. For the 100 institutions, it was found that 62 have a semester instructional term basis and the remaining 38 have a quarter system. Thus, the majority of elementary food preparation courses reported have been designed for classes composed of students with a variety of academic backgrounds and for instructional periods of 14 to 16 weeks.

When asked to specify the number of teaching faculty in the Foods area, the respondents supplied the information in Table 1. It appears that 81 percent of the reporting institutions have five or fewer faculty in the area of Foods. Many respondents indicated that most of their Foods faculty have responsibility for more than one course per term and, in general, participate in both Foods and Food Science and Nutrition instructional programs.

Table 1

Number of Teaching Faculty in Foods Area

Number of Teaching Faculty in Foods Area	Frequency Among Institutions	Percentage (%)
1	16	16.0
2	20	20.0
3	16	16.0
4	19	19.0
5	10	10.0
6	6	6.0
7	5	5.0
8 or more	8	8.0
Range = 1 to 22	100	100.0

Lecture and Laboratory Enrollment Data

Enrollment data detailed in Table 2 demonstrate that, on the average, the elementary food preparation courses at the institutions surveyed are taught each term of the academic year. Each course has a common lecture section for all enrollees that meets once or twice a week for one or two hours as determined by the institutional scheduling policy for operational systems. Since large lecture rooms are usually available on most campuses, it appears that lecture enrollments are determined by the number of laboratory spaces available.

Table 2

Lecture and Laboratory Enrollment Data

Items	Mean		Mode		Range	
	S[a]	Q[b]	S	Q	S	Q
Course credit value(s): lecture + laboratory	3.3	4.1	3	3	2-5	3-6
Number of:						
a. times course is offered each year	2.0	2.8	2	3	1-3	1-4
b. lecture sections/term	1.5	1.3	1	1	1-5	1-4
c. class meetings/lecture section/week	1.5	2.2	1	2	1-4	1-3
d. minutes/lecture session	59	54	50	50	40-120	30-100
e. students possible/lecture section per term (maximum capacity)	54	58	50	60	16-200	18-196
f. students enrolled/lecture section per term (1972-73 average)	44	53	45	50	15-150	18-196
Total possible lecture enrollment/term	78	64	75	60	18-250	24-200
Total actual lecture enrollment/term	63	63	60	60	15-250	24-196
Number of:						
a. laboratory sections/term	3.2	3.2	2	2	1-10	1-9
b. class meetings/laboratory section/week	1.7	1.9	2	2	1-5	1-3
c. minutes/laboratory session	126	125	100	110	100-225	85-240
d. students possible/laboratory section/term (maximum capacity)	20	22	20	24	10-32	16-36
e. students enrolled/laboratory section/term (1972-73 average)	20	22	20	24	10-32	15-36
Total possible laboratory enrollment/term	69	63	60	60	15-240	18-196
Total actual laboratory enrollment/term	71	63	65	60	15-245	12-196

[a]Semester system.

[b]Quarter system.

Each elementary food preparation course has an average of three laboratory sections per term that meet twice a week for two-hour sessions (Table 2). These laboratory sections are filled to capacity (88.9% of courses, 20-22 students per laboratory section) and sometimes oversubscribed by one or two students per laboratory section. Unfortunately, information regarding the number of student enrollment requests denied each term was not requested.

The institutions surveyed were asked to indicate male versus female enrollment figures for the 1972-73 academic year (Table 3). Among the 125 courses listed, 22 (17.6%) had no males enrolled while 84 (67.2%) had less than six per term. Two courses (1.6%) listed per term enrollment of more than 40 male students. These largest male enrollments were in institutions which have Hotel, Restaurant Management Schools.

Table 3

Male Enrollment Per Term Per Course

Number of Males	Frequency Among Courses	Percentage (%)
None	22	17.6
1-5	84	67.2
6-10	9	7.2
11-20	4	3.2
21-30	4	3.2
31-40	0	0.0
Over 40	2	1.6
Total	125	100.0

Instructional and Non-Instructional Staff

Instruction in elementary food preparation at the institutions reporting was predominately limited to one faculty member (87 institutions). Of the 13 remaining, 10 indicated two faculty members were responsible for their elementary food preparation course and 3 each listed three. With the exception of 6 institutions that each listed one male faculty member involved in elementary food preparation instruction, the teaching was done entirely by female faculty members.

Responses to the question concerning the provision of student assistance for faculty with instructional responsibility for courses in elementary food preparation indicated that among the 125 courses reported, 82 had some student assistance provided whereas 43 did not. As shown in Table 4, both male and female graduate and undergraduate students were employed with a predominance (93.9%) of the courses serviced by female graduate and undergraduate students.

Graduate student assignments varied among courses but generally included one or more of the following responsibilities: laboratory section instruction, preparation of market orders, purchase of supplies, examination construction and grading. The usual duties assigned to undergraduate students were: assembling food and supplies for laboratory

Table 4

Student Assistance for Elementary Food Preparation Courses

Number of Students Assisting Each Term	Number of Courses					
	Male GA[a]	Male UA[b]	Female GA[c]	Female UA[d]	Totals (no.)	Totals (%)
1	3	2	42	18	65	79.3
2	--	--	9	4	13	15.8
3	--	--	3	--	3	3.7
4	--	--	1	--	1	1.2
Total	3	2	55	22	82	
Percentage	3.7	2.4	67.1	26.8		100.0

[a]Male Graduate Assistant.

[b]Male Undergraduate Assistant.

[c]Female Graduate Assistant.

[d]Female Undergraduate Assistant.

classes, general laboratory clean-up, supply inventory, laundry and collating mimeographed materials.

Fifty-two of the institutions reporting indicated employment of a maid, housekeeper, or laboratory aide to assist instructors of elementary food preparation courses in the operation of food laboratories. At 32 institutions the instructors had full responsibility for all laboratory functions essential to the courses with no student or technical assistance provided.

Academic Pre-Requisites and Typical Student Composition

Seventy-three of the 125 elementary food preparation courses listed had no pre-requisites. For the remaining 52 courses, the pre-requisites commonly listed were general (inorganic) chemistry, general nutrition and organic chemistry.

Table 5 illustrates the wide range of student academic backgrounds normally present in elementary food preparation courses. The majority of students are in Foods and Nutrition programs or plan to teach Home Economics at the secondary school level. This diversity of academic backgrounds entails many instructional modifications in an attempt to fulfill the needs of those enrolled.

Table 5

Academic Majors Most Commonly Requiring or Electing Enrollment

Required	Elective
Home Economics Education	Elementary Education
Nutrition and Foods	Child Development and Family Relations
Dietetics	General Home Economics
General Home Economics	Nursing
Home Economics in Business	Clothing and Textiles
Consumer Economics	
Food Service and Institution Management	

Not only do students enrolled in elementary food preparation courses differ in academic major, but they also differ in university classification level or state of academic progress in their respective degree programs. Among the 100 institutions reporting usable data, only 13 of the 125 courses listed (10.4%) were composed of students from a single university classification level (Table 6). The remaining 112 courses consisted of classification combinations of two (33.6%), three (24.8%), or four (31.2%) levels. It should be emphasized further that 70 courses (56.0%) contain students from three or more different university classification levels which in itself requires

Table 6

Student Classification Combinations

Classification	Courses Listing Combinations		
	Number	Percentage	
Freshmen only	8	6.4	10.4
Sophomores only	5	4.0	
Freshmen and Sophomores	22	17.6	33.6
Sophomores and Juniors	16	12.8	
Juniors and Seniors	4	3.2	
Freshmen, Sophomores, Juniors	16	12.8	24.8
Sophomores, Juniors, Seniors	15	12.0	
Freshmen, Sophomores, Juniors, Seniors	39	31.2	31.2
Total	125	100.0	100.0

many instructional modifications due to differing states of academic achievement and educational development found in the classroom.

Laboratory Instructional Methods

Tabulation of data in this category revealed that the laboratory instructional methods most commonly used consisted of a combination of techniques. Instructor demonstration of product preparation and discussion of product evaluations followed by student preparation and evaluation of selected products was the combination listed most often. Student-led discussions of product evaluations, demonstrations of product preparation or evaluations of instructor/technician prepared products were listed for less than one-sixth (20) of the 125 courses and comments added by respondents suggested that student participation was very limited in scope. Student self-study programs were listed for five courses to supplement laboratory instruction while no courses had part or all of the laboratory instruction by student independent study or self-instruction methods.

Instructional Texts

A large variety of textbooks was listed for the total 125 elementary food preparation courses including: Foods, Vail, Phillips, Rust, Griswold and Justin; Introductory Foods, Bennion and Hughes; Foundations of Food Preparation, Gladys Peckham; Food Science, Helen Charley; Handbook of Food Preparation, American Home Economics Association. Laboratory manuals used included: Introductory Foods, Morr and Irmiter; Food Study Manual, Helen Charley; Foods, Phillips and Vail. Seventy-two percent of the 125 courses listed by the respondents used laboratory manuals that were staff-prepared.

Summary

A survey of college level course offerings in elementary food preparation at 125 four-year, accredited universities and colleges in the Continental United States produced 100 usable survey data forms which supplied information on 125 courses. This survey was conducted in January 1974 to insure that any instructional techniques developed for use in Human Nutrition and Foods (HNF 100), Elementary Food Preparation, at Michigan State University would be applicable to similar teaching-learning situations involving instruction in basic skills and concepts of food preparation.

Eighty-one percent of the reporting institutions have five or fewer faculty in the area of Foods, with the majority of all Foods Faculty responsible for more than one course per term either in Foods or Food Science and Nutrition. On the average, the elementary food preparation courses at the institutions surveyed are taught each academic term, have one common lecture section for all enrollees, and three laboratory sections per term. These laboratory sections are filled to capacity and sometimes over-subscribed by one or two students per laboratory section.

Male versus female enrollment figures for the 1972-73 academic year showed no males in 17.6 percent of the 125 courses and only two courses (1.6%) with more than 40 male students. The majority of courses (67.2%) listed one to five males enrolled.

Among the 125 courses reported, 82 had some student assistance for faculty with instructional responsibility whereas 43 did not. Both male and female graduate and undergraduate students were employed with a predominance (93.9%) of the courses serviced by female graduate and undergraduate students. At 32 institutions the instructors had full responsibility for all laboratory functions essential to the courses with no student or technical assistance provided.

Seventy-three of the 125 elementary food preparation courses listed no pre-requisites. For the remaining 52 courses, the pre-requisites commonly listed were general (inorganic) chemistry, general nutrition and organic chemistry.

The majority of students enrolled were Foods and Nutrition or Home Economics Education majors. Among the 100 institutions reporting, only 13 of the 125 courses listed (10.4%) were composed of students from a single university classification level. The remaining 112 courses consisted of classification combinations of two (33.6%), three (24.8%), or four (31.2%) levels.

The laboratory instructional method most commonly used was instructor demonstration of product preparation and discussion of product evaluation followed by student preparation and evaluation of selected products. A variety of textbooks are used but laboratory manuals were most often instructor or staff-prepared.

CHAPTER IV

METHODOLOGY

Sample Selection Procedure

The instructional pattern of the four-credit undergraduate course Elementary Food Preparation (HNF 100) is divided into two one-hour lecture periods and two two-hour laboratory sessions per week. Normally, one scheduled lecture time is common for all laboratory sections offered (six to eight sections of 21 students each). However, to maximize the instructional control for this research study, two lecture sections were scheduled for Winter and Spring Terms 1975: one for students enrolled in laboratory sections one through four and the other for students enrolled in the remaining laboratory sections. Students registered for one laboratory section and its corresponding lecture section according to established University procedures with no administrative attempt to influence student laboratory section selection.

Laboratory sections one through four were designated for experimental use for this study for Winter and Spring Terms 1975. To minimize differences attributable to instructors, the investigator had sole responsibility

for presenting all of the lectures, supervising all of the laboratory learning activities, and evaluating individual achievement for all of the students in the four experimental sections each term.

Experimental Design

The lecture content, the applied learning experiences and the evaluation procedures for student achievement for the experimental group (sections 1-4) were modeled after and comparable to those used for the non-experimental group (sections 5-6 or 8). The basic differences were in the variety of instructional strategies used for the applied learning experiences and the specific, but comparable, learning evaluation instruments designed for the experimental group. The experimental instructional design used in Winter Term 1975 was repeated with a second experimental group in Spring Term 1975.

Lecture Section Design

The lecture topics for HNF 100, the sequence of their presentation in 18 sessions and their relation to the laboratory units of study are presented in Table 7. As indicated, half of four lecture periods were used for written testing of student learning in relation to the applied laboratory activities designed to supplement the

Table 7

HNF 100 Lecture Topics: Sequence of Presentation and Relation to Laboratory Units

Topical Sequence	Number of Sessions	Corresponding Laboratory Unit
Course orientation	1	A
Food terminology and food sanitation	1	A
Batters and doughs--Function of ingredients, product structure	2	B
Fats, oils and emulsions	1	B
Starchs, cereals, milk and cheese	1½	C
Laboratory Test I (written): Biscuits, yeast rolls, cream puffs, pie pastry, butter type cakes	½	B
Eggs and egg foams	2	C
Mid-Term Examination (written): Lectures 1 through 9	1	--
Meat, poultry, fish	2	D
Laboratory Test II (written): Starchs, cereals, milk, cheese, eggs, custards, egg foams	½	C
Vegetables	1	E
Fruits	1	E
Laboratory Test III (written): Meats, poultry, fish--dry heat and moist heat methods	½	D
Salads, gelatin, gelatin products	1	E
Beverages	1	--
Laboratory Test IV (written): Vegetables, fruits, salads, mayonnaise dressing, gelatin products	½	E
Review of lecture material	½	--
Total sessions	18	

lecture material. The two-hour final examination covering all of the lecture material was given during the all-university final examination period the last week of the academic term.

Laboratory Units of Study

The division of laboratory subject matter into six units of study, number of sessions per unit and the assignment sequence of performance activities are detailed in Table 8. Each unit of study designates the activity topics as they relate to methods and/or principles of food preparation, composition characteristics, and final product evaluation. Insofar as possible, applied learning activities for the laboratory sessions parallel the subject matter sequence of the lectures.

Methods of Laboratory Instruction

Four methods of laboratory instruction involving five types of instructional strategies were devised for use in this study. The material presented in Table 9 defines these five instructional strategies and indicates how they were used singularly or in combination to design four different instructional methods. The method designated as Control is the usual combination of instructional strategies used for laboratory instruction in HNF 100. Experimental Methods I and II are modifications of the Control Method

Table 8

HNF 100 Laboratory Study Units: Sequence of Laboratory Performance Activities

Units of Study	Number of Sessions	Laboratory Activity Assignment Sequence
A	2	Laboratory orientation Measurement techniques--muffins Product evaluation procedures Laboratory pre-test (entering level skill assessment)
B	4	Biscuits Yeast rolls, fats and oils Cream puffs, pie pastry Butter type cakes
C	4	Starches, cereals Milk and cheese (natural and process) Eggs and custards Egg foam products
D	2	Meat, poultry, fish--moist heat Meat, poultry, fish--dry heat
E	4	Vegetables Fruits Salads, mayonnaise dressing Gelatin products
F	2	Two-part final laboratory examination Written product summary outlines Preparation and evaluation of selected products
Total sessions	18	

Table 9

Four Methods of Laboratory Instruction

Strategies of Instruction	Methods			
		Experimental		
	Control	I	II	III
1. Instructor demonstration of methods of product preparation and discussion of quality characteristics.	X	X	X	
2. Student preparation of selected products and independent evaluation of quality characteristics of student-prepared products.	X			
3. Student independent evaluation of quality characteristics of instructor/technician prepared products.		X		
4. Student independent study. Self-instruction packets and media aids to supplement instructor demonstrations of product preparations and discussion of product quality characteristics.			X	
5. Student independent study. Student learning entirely by self-instruction packets and media aids.				X

designed to reduce the amount of student participation in the preparation of the food products being studied. Experimental Method III eliminates the material costs and labor time associated with product preparation and live demonstration by substituting reusable audio-visual learning materials in the form of slide-tape presentations, study instructions, and activity work sheets for student-directed mastery of the content of the applied learning exercises.

Fifteen independent study modules (slide-tape units and student activity work sheets) were developed by the investigator and assembled for use with Experimental Methods II and III. Each module was designed to parallel the applied experiences of the Control and Experimental I Methods and encompassed the same subject matter, preparation techniques, and quality assessment factors for the food products studied. A representative module (photographs in lieu of slides, audio-script and student work sheets) on the topic "Muffins" is included in Appendix B.

Allocation of Laboratory Instructional Methods Among Laboratory Sections

As shown in Table 8, the laboratory subject matter consisted of six units of study identified as A through F. The instructional design for the four methods of instruction among these six units of study and the four student laboratory sections is illustrated in Table 10.

Table 10

Laboratory Instructional Design for Four Methods Among Six Units of Study and Four Student Laboratory Sections

Laboratory Section	Laboratory Units of Study					
	A	B	C	D	E	F
4	Laboratory Orientation by Instructor Demonstration	Control	Exp. I	Exp. II	Exp. III	Final Laboratory Examination
1		Exp. I	Exp. II	Exp. III	Control	
3		Exp. II	Exp. III	Control	Exp. I	
2		Exp. III	Control	Exp. I	Exp. II	

Instructional procedures for Unit A and laboratory examination procedures for Unit F were identical for all laboratory sections. Only Units B, C, D, and E were taught by each of the four methods under study. In Winter Term 1975 the combinations of laboratory study unit and method of instruction were randomly assigned to the respective laboratory sections as shown in Table 10. To repeat the study in Spring Term 1975 four laboratory sections were scheduled for the same days and hours as sections one through four had been in Winter Term 1975. Each of these Spring Term laboratory sections was matched to its Winter Term counterpart and assigned the same instructional method sequence for study Units A through F.

Essential Laboratory Facilities

The two types of instructional facilities required included traditionally designed food preparation laboratories in the Human Ecology Building and space in the Instructional Media Laboratory in the Life Science Building. Permission for shared use of the Instructional Media Laboratory was granted by the Director of the School of Nursing. Because of its separate location, time records for each student's use of the independent study facility were compiled for each laboratory lesson by the supervisor of the media laboratory unit employed by the School of Nursing.

Instrumentation

Student Background and Experience

Personal information sheet. In order to assess variability among students in background and experience, a personal information sheet was devised to obtain pertinent data (Appendix C). The following information was collected:

1. Name, address and student number.
2. Current enrollment classification, college and major.
3. Grade point average: MSU, Transfer (beginning of term enrolled in HNF 100).
4. Reason(s) for enrollment in HNF 100
   a. Elective versus required.
   b. Delayed enrollment (if applicable).
5. Academic training
   a. Chemistry courses completed: high school and/or college level.
   b. Food courses (including food-related).
6. Experience in food preparation (where, when, type?).

Laboratory pre-test. To further assess entering behaviors of subjects participating in this study, a pre-test was devised by the researcher to attempt a preliminary measure of the student's ability to recognize, identify and/or apply the most basic principles or techniques of practical knowledge of food preparation skills and manipulations (Appendix C). Test questions were formulated to cover five general areas:

1. Basic measurement techniques;
2. Conversion calculations;
3. Techniques of standard methods of food preparation;
4. Food preparation temperatures; and
5. Equipment identification or use.

Evaluation of Student Learning and Performance

Product summary outlines. Instruction in HNF 100 places major emphasis on the application of principles to the steps in preparation of food products. One typical or representative product is chosen from each of the four major laboratory units of study (B, C, D, E) and each student is required to complete a written summary outline for each of the selected products. The summary outline forms provided in the 1975 Morr and Irmiter Introductory Foods Laboratory Manual were used for these exercises. The task involves a three-step process. The first step requires that the student list the ingredients and their quantities. Next, the student identifies the most important points or major steps in preparation. Last, and most important, is the task of explaining each of their chosen steps on the basis of (a) ingredient functions involved, (b) principles involved in the manipulation or technique and (c) the resultant changes that might occur at that point.

Product evaluations. For three instructional methods (Control, Experimental I and II), product evaluations for selected items were required written assignments for each student for all laboratory units of study. The evaluation forms provided in the 1975 Morr and Irmiter Introductory Foods Laboratory Manual were used for these exercises. In the case of Experimental Method III (independent or self-instruction), evaluation descriptions of products were provided for the student in the taped narration of the slide presentations and a product evaluation form in the student work sheet packet (Appendix B) was completed by the student for study purposes. For all methods, selected products were evaluated on the basis of volume, external appearance, texture or consistency, tenderness and taste or flavor.

Laboratory unit tests. At the end of each laboratory unit of study (B, C, D, E) a 30-minute objective written test was given. The tests included multiple choice, matching and true-false items. Each test was designed to measure learning achievement in four areas: application of principles to procedural steps in the preparation of representative food products, knowledge of process techniques, ingredient functions, and product quality characteristics. All tests were constructed by the experimenter and reviewed for content validity by two food specialists of the

Department of Food Science and Human Nutrition, Michigan State University. Each question was limited to one correct answer and the tests were machine scored by the university on-campus scoring service. An item analysis (especially for Kuder-Richardson Reliability Coefficients) was done for each unit test (input data, Opscan 100; output data, IBM 360).

Laboratory final examination. The laboratory final examination was administered in two parts, written and practical, each of which required one, two-hour laboratory period for completion. For Part I, the written segment of this experience, students in each laboratory section were given a four-item menu with one representative food product from each of the four laboratory units of study (B, C, D, E) and asked to complete a product summary outline for each of the products. Students were permitted to use reference notes and their Morr and Irmiter Introductory Foods Laboratory Manual (1975) in this exercise. Each laboratory section had a different food-item menu but, among sections, all items were similar in level of difficulty and in the principles and techniques involved in preparation. Grading for this part of the final examination was done on the same basis as had been used for all product summary outlines during the term.

Part II of the laboratory final examination, the practical segment of this experience, was given during the last laboratory session for the course. In each laboratory section the students were divided into groups of four or five persons and, within groups, each student drew a slip of paper designating the one product from the menu he/she was assigned to prepare. When all menu items for the group were service-ready, each product was independently evaluated in writing by every member of the group. The selection of all products for preparation in Part II of the examination were reviewed by the investigator and two faculty members of the Food Science and Human Nutrition Department for appropriateness, similarity and level of difficulty within and among groups and among laboratory sections.

As a result of the two-part examination procedure each student received three grades: a product summary outline grade (average of four outlines, Part I); a product preparation performance grade; and a product evaluation grade (average of the evaluations of the student-prepared products, Part II). Finally, the grades for these three categories of student performance were averaged and this grand average became the grade for the final laboratory examination.

Mid-term and final course examinations. The mid-term and final course examinations were designed to measure

student mastery of the theoretical concepts of food preparation as presented through the lectures given by the instructor and supplemented by the out-of-class assigned readings. Achievement on these examinations, though essential to the calculation of the final course grade for each student, were not relevant for comparative assessment of the effectiveness of the laboratory instructional methods used in this investigation.

Total course grade. Each student's total numerical point score was calculated according to the following distribution of component weights:

Mid-term examination	20%
Final course examination	30%
Laboratory tests (I-IV)	20%
Daily laboratory	
Summary outlines	10%
Product evaluations	10%
Laboratory final examination	10%
	100%

The numerical point scores arrived at in this manner were then converted to the university point system (4.0 scale) for reporting grades.

Student Attitudinal Information

Laboratory study unit reactionnaire. At the conclusion of laboratory units B, C, D and E, students were asked to complete a two-page evaluation form designed to elicit their reactions to the instructional method used for the

specific unit of laboratory work. In the major portion of the instrument students were directed to record their reactions to a series of structured statements on a five-point attitudinal response scale with intervals ranging from strongly agree to strongly disagree. In addition, four general open-ended questions were posed to provide opportunity for the personal comments about the laboratory activities for the study unit, the method of instruction used and the quality of learning realized.

Two separate but similar forms were designed to accommodate student assessment of the four different methods of laboratory instruction under consideration. One form was constructed for use with the Control Method and the Experimental Method I. This form was then modified slightly so some of the structured statements were more applicable to the use of independent study materials for learning as required in Experimental Methods II and III. Both versions of the Laboratory Study Unit Reactionnaire for this investigation were adapted from opinion measurement instruments developed by the Division of Learning and Evaluation Services, Michigan State University. Copies of the two forms used for this study are included in Appendix C.

Six particular areas of student assessment important to the investigator's evaluation of comparative

effectiveness among methods for each laboratory study unit were basic to the construction of the instruments:

1. Clarity of lesson objectives and directions;
2. Topic organization and continuity;
3. Rate of presentation;
4. Terminology and example products used to illustrate principles;
5. Overall quality of the instructional method; and
6. Development of positive interest in the subject matter.

Final laboratory evaluation. This instrument was designed to ascertain student reactions concerning the comparative merits of the four laboratory instructional methods in relation to learning effectiveness among Laboratory Study Units B, C, D, and E. The Student Reactionnaire: Final Laboratory Evaluation form was developed by the investigator and reviewed for appropriateness and clarity of content by two department faculty members with specialization in the area of Foods. A copy of this evaluation instrument is included in Appendix C.

To complete this evaluation, the student was first asked to rank the laboratory instructional methods from one to four (most to least) on completeness of presentation of instructional information. Next, the student was asked to indicate which instructional method or combination of

methods he/she felt was best suited for the instruction of Unit B, Unit C, Unit D and Unit E. The four remaining questions were open-ended and asked for comparisons of amounts of learning realized from the different instructional methods, personal comments concerning the laboratory portion of HNF 100, and an indication of the amount of previous food preparation experience of the respondent.

Time Involvement Records

Students. Individual student time records were kept for all independent study laboratory sessions taught for Experimental Methods II and III. Check-in and check-out times and total time (minutes) for initial and repeat sessions were tabulated and averaged to obtain the mean group average for students assigned Experimental Method II and III each laboratory session. Among method comparisons of average required time within and among Laboratory Units B, C, D and E were made.

Instructional staff. The instructional staff time devoted to each of three types of laboratory-associated activities was estimated, recorded and summarized:

a. Pre-preparations essential for instructor demonstrations;

b. Compilation of market and equipment orders; and

c. Instruction, grading and student counseling.

Non-instructional staff. Estimates of the amount of non-instructional staff time required to perform five types of activities for each laboratory unit of study were recorded and summarized:

a. Shopping for food supplies;

b. Assembly and delivery of food supplies to appropriate laboratory locations;

c. Assembly and delivery of special equipment and linens to appropriate laboratory locations;

d. Return of unused food and supplies to appropriate storage areas; and

e. General clean-up tasks at the end of each laboratory session.

Laboratory Operational Costs

Food supplies. Market order records for each laboratory session were costed by the item amount used. Total costs for each laboratory unit of study (A, B, C, D, E, F) and per student costs per term were calculated.

Instructional and non-instructional support staff. Average Faculty, Graduate Teaching Assistant, Laboratory Aide and Work-Study Student salaries were estimated and the proportionate costs for operation of the laboratories calculated.

Hypotheses of the Study

The four operational null hypotheses formulated for this study were:

1. The achievement of undergraduate students in the laboratory portion of an elementary food preparation course taught by Experimental Methods I, II or III will not differ significantly from the achievement of comparable students taught by the Control Method for Laboratory Study Units B, C, D or E.

   1.1 The achievement on Laboratory Test I (Study Unit B), Laboratory Test II (Study Unit C), Laboratory Test III (Study Unit D) and Laboratory Test IV (Study Unit E) of undergraduate students taught by Experimental Methods I, II or III will not differ significantly from the achievement on Laboratory Tests I, II, III or IV of comparable students taught by the Control Method.

   1.2 The achievement on Product Summary Outlines for Laboratory Study Units B, C, D or E of undergraduate students taught by Experimental Methods I, II or III will not differ significantly from the achievement on Product Summary Outlines for Study Units B, C, D or E of comparable students taught by the Control Method.

2. The achievement of undergraduate students on the Final Laboratory Examination for an elementary food preparation course will not differ significantly among four laboratory sections taught by four different instructional method sequences.

3. The attitudes of undergraduate students in the laboratory portion of an elementary food preparation course taught by Experimental Methods I, II or III will not be equivalent to nor more favorable than the attitudes of comparable students taught by the Control Method for Laboratory Study Units, B, C, D or E.

4. The per student laboratory operational costs for expendable materials and instructional and non-instructional personnel for the laboratory portion

of an elementary food preparation course taught by Experimental Methods I, II or III will not be less than comparable per student costs for the Control Method of laboratory instruction.

Analysis of the Data

Pre-Test Scores

Student pre-test scores were subdivided into five general categories:

1. Basic measurement techniques;
2. Conversion calculations;
3. Techniques of standard methods of food preparation;
4. Food preparation temperatures; and
5. Equipment identification or use.

The mean number of items correct, incorrect, or no opinion per laboratory section per category were calculated and compared using Student's *t* distribution (Hoel, 1966).

Product Evaluations

Mean scores on product evaluations for the Control, Experimental I and Experimental II Methods of instruction were calculated and compared for each laboratory section within the laboratory units of study. Student's *t* distribution was used for analysis of the data.

Laboratory Unit Tests, Product Summary Outlines, and Final Laboratory Examination

The evaluation data generated by laboratory unit tests and product summary outlines were tested using one-way analysis of variance to yield F-ratios for methods (Glass and Stanley, 1970). Analysis of variance as applied to final laboratory examinations yielded F-ratios for groups. When null hypotheses were rejected, the planned comparison method (Glass and Stanley, 1970) was utilized to determine differences attributable to instructional methods. Since specific hypotheses were formulated to indicate desired performances before research endeavors were undertaken, planned comparisons were justified.

Laboratory unit tests were analyzed for reliability using the Kuder-Richardson Formula 20 (Ebel, 1972). Test content was validated by three subject matter experts of the Department of Food Science and Human Nutrition.

Attitudinal Data

Responses to individual questions were categorized and compared within laboratory units of study by different instructional methods (Control, Experimental I, II or III). The mean extent of agreement or favorableness was determined by weighting individual responses from one to five (least to most) and then calculating the mean values for categories on

all combined Winter and Spring Term 1975 student reactionnaires. Responses on subjective questions are reported as relative discussions of opinion.

All other comparisons of the study were based on mean values or tabulated opinion results.

CHAPTER V

RESULTS AND DISCUSSION

The Sample

To maximize the instructional control for this research study, four of the HNF 100 laboratory sections and a corresponding lecture section, all taught by the investigator, were designated as experimental sections for Winter Term and for Spring Term, 1975. Students registered according to established University procedures with no administrative attempt to influence student laboratory section selection. Since no effort was made to select students with specific characteristics or to assign them randomly to groups, the first task of this research endeavor was that of characterization of the 153 subjects in the sample. This analysis and summary of sample composition was necessary to demonstrate consistent similarities (lack of variability) among laboratory groups to insure potential comparability of the research findings within and among the four laboratory instructional methods under investigation.

Assessment of variability among students in background and experience was done by data obtained through two

different measurement instruments: a personal information sheet and a written laboratory pre-test administered during the first laboratory session of the instructional term.

Personal Information Sheet

The personal information sheet found in Appendix C was used to collect the data summarized in Table 11. Each laboratory section (Winter and Spring Terms, 1975) was composed of Freshmen, Sophomores, Juniors and Seniors with the predominant segment (range of 42 to 83%) being Sophomores and Juniors. The mean MSU Grade Point Average per laboratory section ranged from a low of 2.66 to a high of 2.88 (difference of 0.22) indicating a similarity in previous student achievement among the sections.

In each of the eight laboratory sections, 50 percent or more of the students were enrolled as majors in the Hotel, Restaurant and Institutional Management program of the College of Business with the second largest student group representing the Home Economics Education program of the College of Human Ecology. These two majors made up 62 (Section 1, Winter 1975) to 83 percent (Section 4, Spring 1975) of the total enrollment for each laboratory section. Other academic majors included: Botany, Pre-Law, Communications, Nursing, Consumer Services, Zoology, Clothing and Textiles, Horticulture, Dietetics, Business Administration and No Preference (no declared major).

Table 11

Summary of Student Personal Information: Academic Background and Experience

Item	Laboratory Section							
	Winter Term 1975				Spring Term 1975			
	1	2	3	4	1	2	3	4
Number of students enrolled:	16	18	21	20	18	21	21	18
Student classification:								
Freshman	2	1	1	2	5	4	4	3
Sophomore	4	4	9	7	6	7	5	7
Junior	7	11	8	9	6	6	9	5
Senior	3	2	3	2	1	4	3	3
Grade Point Average:								
Michigan State University	2.83[a]	2.67	2.88	2.72	2.80	2.85	2.66	2.79
Transfer	--[b]	--	--	--	--	--	--	--
Academic major:								
Hotel, Restaurant, and Institutional Management	8	11	14	11	11	12	12	11
Home Economics Education	2	3	2	4	3	3	4	4
Other	6	4	5	5	4	6	5	3
Reason(s) for enrollment:								
Required	12	17	17	15	13	17	19	15
Elective	4	1	4	5	5	4	2	3
Delayed: Yes	0	6	3	2	2	5	4	2
No	16	12	18	18	16	16	17	16
Academic training:								
Chemistry:								
College: Inorganic	1	8	4	6	4	3	6	2
Organic	0	2	0	0	2	0	2	2
High School	5	11	15	12	10	14	9	11
Foods:								
College:								
Food and the Consumer (HNF 221, 222)	1	1	1	0	3	1	3	3
Cultural Foods (HNF 406, 406L)	0	0	0	0	1	0	0	0
Other	2	5	6	4	1	2	1	0
High School	0	0	1	0	1	2	0	0
Previous food preparation experience:								
Quite a lot	0	1	2	2	0	1	3	2
Some	2	4	5	5	4	4	4	4
None	14	13	14	13	14	16	14	12

[a]Values expressed as means.

[b]No first-term transfer students were enrolled.

As indicated by the figures enumerated under reasons for enrollment (Table 11), 72 percent or more of the students in each laboratory section were required by their degree programs to take HNF 100 and most had not been refused enrollment prior to the current term.

Although chemistry, inorganic or organic, is not a pre-requisite for HNF 100, it is pertinent to define the number of students with this particular background since training in chemistry, especially the scientific terminology, might be an advantage in a course that includes many technical procedures. Academic training in chemistry was most prevalent as high school general chemistry (average of 11 students per laboratory section; range 5 to 15). No more than two students per laboratory section had had organic chemistry at the college level while a slightly larger number per laboratory section had taken inorganic chemistry (average of 4; median of 4; range 1 to 8).

Another academic training area that might significantly affect student performance in HNF 100 is that of previous courses taken in Foods or related curricula. This was measured by assessment of the number of students who had taken Food and the Consumer (HNF 221, 222) and/or Cultural Aspects of Food (HNF 406, 406L) at Michigan State University or similar courses at another college or university. Data collected for this item indicated that at least 91 percent

of all students enrolled had never taken HNF 221, 222, 406 or 406L. Other college or university courses related to food preparation were also infrequently mentioned with no student having had more than one such course. High school foods courses were listed by only four of the total 153 students. Thus, previous food course experiences were deemed negligible in effect for all laboratory sections.

In order to assess student perception of previous food preparation experiences, the last item on the personal information sheet asked each student to list employment situations where he/she had performed actual food preparation tasks. Three categories (quite a lot, some, none) were designated by the investigator to include the following:

a. Quite a lot--full meal preparation or major portions of a meal.

b. Some--short-order cook, cafeteria (vegetables, salads, etc.)

c. None.

Actual work experiences were then matched to the above categories and summarized. Tabulated results indicate that at least 65 percent of the students per laboratory section had had no previous food preparation experience (average of 72.5%; range of 65-88%); at least 12.5 percent had had some food preparation experience (average of 21%; range of 12.5-25%); and no more than 14 percent had had quite a lot

of food preparation experience (average of 7%; range of 0-14%). Among the eight experimental laboratory sections the amount of student previous food preparation experience was found to be quite similar but relatively minor.

Laboratory Pre-Test

The written laboratory pre-test was designed as a preliminary measure of the student's ability to recognize, identify and/or apply the most basic principles or techniques of practical knowledge of food preparation skills and manipulations (Appendix C). The mean number of items for each laboratory section answered correctly, incorrectly or no opinion in five general areas are shown in Table 12. As a further attempt to characterize the sample composition by laboratory section, these data were analyzed by Student's t (Hoel, 1966) for differences among laboratory sections within Winter and within Spring Terms, 1975 (Table 13) and between Winter and Spring Terms, 1975 (Table 14). The primary focus for discussion, however, concerns differences among means for correct responses for laboratory sections within each area of knowledge tested.

Basic measurement techniques. On the average, six of the eight laboratory sections correctly answered at least one-half of the questions in this category. Statistical analysis of the differences in means showed no significant differences among laboratory sections within Winter or

Table 12

Mean Number of Items Answered Correctly, Incorrectly or No Opinion on Laboratory Pre-Test

Area of Knowledge	Laboratory Section							
	Winter Term 1975				Spring Term 1975			
	1	2	3	4	1	2	3	4
Number of students enrolled	16	18	21	20	18	21	21	18
Number of students completing pre-test	11	18	18	20	18	21	20	18
Basic measurement techniques (T = 8):								
Correct	3.45 ± 3.10[a]	3.72 ± 1.22	4.22 ± 1.16	4.80 ± 1.63	4.37 ± 1.61	4.38 ± 1.83	4.35 ± 1.39	4.05 ± 1.52
Incorrect	2.64 ± 2.35	3.22 ± 1.31	3.00 ± 1.53	2.10 ± 1.12	2.26 ± 1.24	2.76 ± 1.34	2.95 ± 1.33	2.16 ± 1.26
No opinion	1.91 ± 1.92	1.06 ± 1.16	0.78 ± 1.26	1.10 ± 1.58	1.37 ± 1.26	0.86 ± 1.49	0.70 ± 1.02	1.79 ± 1.81
Conversion calculations (T = 6):								
Correct	1.82 ± 1.33	3.50 ± 0.98	3.22 ± 1.35	3.14 ± 1.42	2.89 ± 1.82	2.81 ± 1.44	2.40 ± 1.27	2.58 ± 1.50
Incorrect	4.18 ± 1.33	2.50 ± 0.98	2.78 ± 1.35	2.86 ± 1.42	3.11 ± 1.82	3.19 ± 1.44	3.60 ± 1.27	3.42 ± 1.50
Techniques of standard methods of food preparation (T = 15):								
Correct	8.36 ± 1.80	9.17 ± 2.75	8.50 ± 2.50	9.40 ± 2.56	9.05 ± 3.12	9.00 ± 2.60	8.50 ± 2.58	9.63 ± 2.34
Incorrect	6.64 ± 1.80	5.83 ± 2.75	6.50 ± 2.50	5.60 ± 2.56	5.95 ± 3.12	6.00 ± 2.60	6.50 ± 2.58	5.37 ± 2.34
Food preparation temperatures (T = 10):								
Correct	2.45 ± 1.69	2.94 ± 2.86	2.44 ± 2.48	2.67 ± 2.37	1.37 ± 1.61	2.90 ± 2.45	2.25 ± 2.31	2.11 ± 1.88
Incorrect	7.55 ± 1.69	7.06 ± 2.86	7.56 ± 2.48	7.33 ± 2.37	8.63 ± 1.61	7.10 ± 2.45	7.75 ± 2.31	7.89 ± 1.88
Equipment identification or use (T = 16):								
Correct	10.64 ± 3.01	9.56 ± 3.43	10.50 ± 2.31	10.33 ± 2.69	9.32 ± 2.26	9.48 ± 3.16	10.15 ± 2.67	10.00 ± 3.06
Incorrect	5.36 ± 3.01	6.44 ± 3.43	5.50 ± 2.31	5.67 ± 2.69	6.68 ± 2.26	6.52 ± 3.16	5.85 ± 2.67	6.00 ± 3.06

[a]Mean ± Standard Deviation.

Table 13

Significance of Difference in Mean Number of Items Answered Correctly on Laboratory Pre-Test

Item	Winter Term 1975		Spring Term 1975	
	Lab. Sec. Compared	Significance of "t"	Lab. Sec. Compared	Significance of "t"
Basic measurement techniques: Correct	all possible	ns[a]	all possible	ns
Conversion calculations: Correct	1,2 1,3 1,4 others	P < 0.005 P < 0.01 P < 0.01 ns	all possible	ns
Techniques of standard methods of food preparation: Correct	all possible	ns	all possible	ns
Food preparation temperatures: Correct	all possible	ns	1,2 1,3 others	P < 0.005 P < 0.05 ns
Equipment identification or use: Correct	all possible	ns	all possible	ns

[a]Ns = not significant determined by Student's t (Hoel, 1966).

Table 14

Significance of Difference in Mean Number of Items Answered Correctly on Laboratory Pre-Test: Comparison of Winter and Spring Terms, 1975

Item	Lab. Sections Compared Winter, Spring	Significance of "t"
Basic measurement techniques:		
Correct	2,1	$P < 0.05$
	2,2	$P < 0.05$
	2,3	$P < 0.05$
	others	ns[a]
Conversion calculations:		
Correct	1,1	$P < 0.025$
	1,2	$P < 0.05$
	2,1	$P < 0.025$
	2,2	$P < 0.01$
	2,3	$P < 0.005$
	2,4	$P < 0.005$
	3,3	$P < 0.025$
	4,3	$P < 0.05$
	others	ns
Techniques of standard methods of food preparation:		
Correct	1,4	$P < 0.05$
	others	ns
Food preparation temperatures:		
Correct	2,1	$P < 0.05$
	4,1	$P < 0.025$
	others	ns
Equipment identification or use:		
Correct	3,1	$P < 0.05$
	others	ns

[a]Ns = not significant determined by Student's *t* (Hoel, 1966).

Spring Terms, 1975 (Table 13). However, the mean number of items answered correctly by Laboratory Section 2, Winter Term 1975, was significantly lower ($P < 0.05$) than the respective means for Laboratory Sections 1, 2 and 3 of Spring Term 1975 (Table 14). This difference for Laboratory Section 2 of Winter Term appears to be a true difference in knowledge since the mean for the no opinion answers does not indicate that this group tended to guess or refrain from guessing to a greater extent than the majority of the other laboratory sections.

Conversion calculations. Statistical analysis of the responses for this category of questions yielded more significant differences within and between instructional terms than any of the other four areas of questions. In Winter Term 1975, the mean number of items answered correctly by Laboratory Section 1 was significantly lower than the means for Laboratory Sections 2 ($P < 0.005$), 3 ($P < 0.01$) and 4 ($P < 0.01$) (Table 13). There were no differences in achievement among Spring Term 1975 laboratory sections (Table 13). A comparison of Winter and Spring Terms laboratory sections (Table 14) revealed that Laboratory Section 1 of Winter Term answered significantly fewer items correctly than did Sections 1 or 2 of Spring Term; Laboratory Section 2 of Winter Term answered significantly more items correctly than did any of the Spring Term laboratory

sections, while Laboratory Sections 3 and 4 of Winter Term answered significantly more items correctly than did Laboratory Section 3 of Spring Term. With the exception of Laboratory Section 1 of Winter Term, the trend of performance for this category appears to indicate that Winter Term laboratory sections were more proficient than Spring Term laboratory sections in the correct completion of this task.

Techniques of standard methods of food preparation. Fifteen questions were included in this category and each of the laboratory sections achieved an average number of correct responses greater than one-half the maximum number possible (Table 12). No significant differences in the mean number of correct items were found among laboratory sections within Winter and within Spring Terms 1975. Laboratory Section 1 of Winter Term did have an average score significantly lower ($P < 0.05$) than Laboratory Section 4 of Spring Term (Table 14), but no other differences between Winter and Spring Term laboratory sections were found.

Food preparation temperatures. Each of the eight laboratory sections obtained mean correct scores of less than one-third the maximum possible score. The laboratory sections of Winter Term 1975 did not differ significantly from each other on the mean number of items answered correctly. Laboratory Section 1 of Spring Term had a

significantly lower mean score than did Laboratory Sections 2 ($P < 0.005$) or 3 ($P < 0.05$) of that same instructional term and also scored significantly lower than Laboratory Sections 2 ($P < 0.05$) and 4 ($P < 0.025$) of Winter Term.

Equipment identification and use. Within Winter and Spring Terms 1975 no significant differences were found among the laboratory sections on the mean number of items answered correctly (Table 13). When the laboratory sections of Winter Term were compared to Spring Term laboratory sections, only one significant difference was evident; Laboratory Section 3 of Winter Term had a significantly higher mean score ($P < 0.05$) than Laboratory Section 1 of Spring Term (Table 14). Each of the eight laboratory sections obtained a mean correct score greater than one-half the maximum possible score.

Summary of Sample Characterization

Assessment of the variability among students and the differences among the eight experimental laboratory sections of Winter and Spring Terms 1975 on background and experience was done by analysis of personal information data and laboratory pre-test data.

Students enrolled in each laboratory section were predominantly Sophomores and Juniors and laboratory sections did not differ in mean MSU Grade Point Averages. Fifty

percent or more of the students in each laboratory section were Hotel, Restaurant and Institutional Management Majors with 62 to 83 percent of the total enrollment per laboratory section composed of Hotel, Restaurant and Institutional Management Majors and Home Economics Education Majors who have HNF 100 as a requirement for their respective degree programs. Twenty-four (15.7%) of the 153 students enrolled had been refused admission to the course in at least one prior term.

Academic training in chemistry was most prevalent as high school general chemistry. Previous food course experiences were few and judged negligible in effect for all laboratory sections. Sixty-five percent or more of the students per laboratory section had had no previous food preparation experience through job responsibilities.

Information obtained from the personal information sheet indicated little variation among laboratory section enrollees for the factors of enrollment classification, mean grade point average, academic major, academic training (chemistry or foods) or previous food preparation experience.

Comparison of the mean number of correct responses per area of knowledge tested (written laboratory pre-test) by Student's t revealed the following significant differences between laboratory sections:

Basic measurement techniques

The mean number of items answered correctly by Laboratory Section 2 of Winter Term 1975 was significantly lower than means for Laboratory Sections 1, 2 and 3 of Spring Term 1975.

Conversion calculations

The mean number of items answered correctly by Laboratory Section 1 of Winter Term 1975 was significantly lower than the means for Laboratory Sections 2, 3 or 4 of Winter Term.

Laboratory Section 1 of Winter Term answered significantly fewer items correctly than Sections 1 or 2 of Spring Term.

Laboratory Section 2 of Winter Term answered significantly more items correctly than Sections 1, 2, 3 or 4 of Spring Term.

Laboratory Sections 3 and 4 of Winter Term answered significantly more items correctly than Section 3 of Spring Term.

Techniques of standard methods of food preparation

The mean number of items answered correctly by Laboratory Section 1 of Winter Term was significantly less than Section 4 of Spring Term.

Food preparation temperatures

Laboratory Section 1 of Spring term had a significantly lower mean score than Laboratory Sections 2 or 3 of that same term.

Equipment identification and use

The mean number of items answered correctly by Laboratory Section 3 of Winter Term was significantly greater than Laboratory Section 1 of Spring Term.

Differences are indicated and laboratory sections characterized to provide evidence for valid interpretation of the research findings on the basis of comparable groups within the sample.

Evaluation of Student Learning and Performance

The experimental design for this research study involved a Latin Square arrangement for the comparison of four methods of laboratory instruction for four laboratory units of study for four groups of students. In this Latin Square design every laboratory instructional method was applied to each laboratory unit of study and during the term students in every laboratory section experienced every laboratory instructional method once which made a balanced comparison possible. Another particular feature of the Latin Square is that every laboratory instructional method followed every other method the same number of times to balance or minimize carry-over effects.

Within this experimental design, three evaluation instruments were used to obtain information on student learning and performance to assess the effectiveness of each laboratory instructional method within each of the four laboratory units of study (B, C, D and E). Product summary outlines, product evaluations and laboratory unit tests were the evaluation instruments administered to collect the relevant data for analysis. A two-part laboratory final examination supplied data for the comparison of the overall performance among laboratory sections.

Product Summary Outlines

One typical or representative product was chosen by the investigator from each of the four major laboratory units of study (B, C, D and E) and each student was required to complete a written summary outline for each of the selected products. Because of the uneven numbers of students in the laboratory sections and an enrollment of only 16 students for Laboratory Section 1 Winter Term 1975, scores for 16 students from each laboratory section were selected for analysis by use of a table of random numbers (Glass and Stanley, 1970). Product summary outline data were tested using one-way analysis of variance (ANOVA) to yield F values for methods. When F values were statistically significant, planned comparisons to determine differences attributable to instructional methods were made. Winter and Spring Terms data were first analyzed by term and then combined for compound analysis.

Laboratory Unit B. Analysis of variance data for Winter Term 1975 Laboratory Unit B product summary outlines are presented in Table 15. The calculated F value of 2.33 does not exceed the value of 2.76 ($_{.950}F_{3,59}$) required for significance.

Table 15

Comparison of Laboratory Unit B Product Summary Outline Scores for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4	16	77.88	1,246	1,552,516	99,476
I	1	15	78.87	1,183	1,399,489	94,541
II	3	16	84.44	1,351	1,825,201	114,577
III	2	16	84.88	1,358	1,844,164	116,510

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	634.38	3	211.46	2.33
Within	5,437.18	59	90.61	

[a] C = Control; I, II, III = Experimental.

Tables 16 (Spring Term) and 17 (combined Winter and Spring Terms) also present non-significant F values of 1.21 ($_{.950}F_{3,60} = 2.76$) and 2.48 ($_{.950}F_{3,123} = 2.68$), respectively.

There are, therefore, no differences in mean product summary outline scores for Laboratory Unit B for the laboratory sections taught by the Control, Experimental I, II or III Methods of laboratory instruction. Any one of the three experimental instructional methods tested could be applied to this unit of study and obtain the same level of student achievement on the assignment of writing a product summary outline as by the Control Method.

Table 16

Comparison of Laboratory Unit B Product Summary Outline Scores for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1	16	85.13	1,362	1,855,044	117,192
I	3	16	83.69	1,339	1,792,921	112,915
II	2	16	83.50	1,336	1,784,896	112,572
III	4	16	88.31	1,413	1,996,569	125,595

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	237.81	3	79.27	1.21
Within	3,934.63	60	65.57	

[a]C = Control; I, II, III = Experimental.

Table 17

Comparison of Laboratory Unit B Product Summary Outline Scores for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4 + 1	32	81.50	2,608	6,801,664	216,668
I	1 + 3	31	81.35	2,522	6,360,484	207,456
II	3 + 2	32	83.97	2,687	7,219,969	227,149
III	2 + 4	32	86.59	2,771	7,678,441	241,661

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	581.91	3	193.97	2.48
Within	9,629.79	123	78.29	

[a]C = Control; I, II, III = Experimental.

Laboratory Unit C. Analysis of variance data for Winter Term 1975, Unit C product summary outlines are presented in Table 18. The calculated F value of 1.66 does not exceed the value of 2.76 ($_{.950}F_{3,59}$) required for significance.

Table 18

Comparison of Laboratory Unit C Product Summary Outline Scores for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2	16	77.88	1,246	1,552,516	98,226
I	4	16	74.56	1,193	1,423,249	93,257
II	1	15	79.20	1,188	1,411,344	95,114
III	3	16	83.38	1,334	1,779,556	112,242

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	638.10	3	212.70	1.66
Within	7,541.84	59	127.82	

[a] C = Control; I, II, III = Experimental.

Table 19 presents ANOVA data for Spring Term 1975, Unit C product summary outlines. The calculated F value of 2.93 does exceed the value of 2.76 ($_{.950}F_{3,60}$) required for significance. Since the F value of 2.93 (Table 19) is significant, a difference does exist between mean scores on Laboratory Unit C product summary outlines for laboratory

Table 19

Comparison of Laboratory Unit C Product Summary Outline Scores for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4	16	91.56	1,465	2,146,225	134,273
I	1	16	94.25	1,508	2,274,064	142,568
II	3	16	87.69	1,403	1,968,409	124,491
III	2	16	91.25	1,460	2,131,600	133,562

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	348.37	3	116.12	2.93*
Within	2,375.38	60	39.58	

[a] C = Control; I, II, III = Experimental.

*Significant at $P < 0.05$ level of probability.

sections taught by the Control, Experimental I, II or III laboratory instructional methods.

An original aim of this research study stipulated the development of alternative instructional methods for the laboratory portion of HNF 100 that would produce student achievement or performance equivalent to or better than the current method (Control) of instruction. Since the F value of 2.93 (Table 19) is significant, the next step of analysis, therefore, is to ascertain which of the experimental methods of instruction (Experimental I, II or III) as compared to the Control meet this equivalent to or better than

requirement for substitution in Unit C. The planned comparison method of analysis was used for this determination (Glass and Stanley, 1970), and the resultant data are presented in Table 20. Contrasts of Experimental I, II and III Methods of instruction to the Control Method yield F values of 1.46, 3.03 and 0.02, respectively. None of these F values are significant since no calculated value exceeds the critical value of 4.00 ($_{.950}F_{1,60}$) necessary for significance. The significance of the omnibus F of 2.93 is therefore not attributable to any one of the contrasts considered of prime importance for this study. The conclusion from this analysis can then be stated as follows: Spring Term Laboratory Unit C mean product summary outline scores for the laboratory sections taught by Experimental Methods I, II or III do not differ significantly from the mean score for the laboratory section taught by the Control Method.

When Laboratory Unit C product summary outline scores for Winter and Spring Terms 1975 were combined by appropriate laboratory sections and analyzed by one-way ANOVA the data in Table 21 were obtained. The calculated F value of 0.65 does not exceed the value of 2.68 ($_{.950}F_{3,123}$) required for significance.

Table 20

Planned Comparisons of Laboratory Unit C Product Summary Outline Scores for Four Methods of Instruction: Spring Term, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	348.37	3	116.12	2.93*
Contrasts:				
1. Control vs. Exp. I	57.89	1	57.89	1.46
2. Control vs. Exp. II	119.82	1	119.82	3.03
3. Control vs. Exp. III	0.77	1	0.77	0.02
Within	2,375.38	60	39.58	

*Significant at $P < 0.05$ level of probability.

Table 21

Comparison of Laboratory Unit C Product Summary Outline Scores for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2 + 4	32	84.72	2,711	7,349,521	232,499
I	4 + 1	32	84.41	2,701	7,295,401	235,825
II	1 + 3	31	83.58	2,591	6,713,281	219,605
III	3 + 2	32	87.31	2,794	7,806,436	245,809

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	247.42	3	82.47	0.65
Within	15,570.62	123	126.59	

[a] C = Control; I, II, III = Experimental.

As evidenced by these analyses, any one of the experimental instructional methods tested could be applied to this unit of study and obtain the same level of student achievement on the assignment of writing a product summary outline as by the Control Method.

Laboratory Unit D. Analysis of variance data for Winter Term 1975, Unit D product summary outlines are presented in Table 22. The calculated F value of 18.43 is significant at the $P < 0.001$ level of probability ($_{.999}F_{3,58} = 6.17$).

Table 22

Comparison of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3	16	95.69	1,531	2,433,961	146,693
I	2	14	88.57	1,240	1,537,600	110,268
II	4	16	80.81	1,293	1,671,849	105,145
III	1	16	84.19	1,347	1,814,409	114,185

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,976.59	3	658.86	18.43*****
Within	2,073.75	58	35.75	

[a] C = Control; I, II, III = Experimental.

*****Significant at $P < 0.001$ level of probability.

The data in Table 23 reports the F values obtained by the planned comparisons method of analysis. Each of the three contrasts pertinent to the research study yield significant F values and are interpreted as follows: the Laboratory Unit D mean product summary outline score for the laboratory section taught by the Control Method of instruction was significantly greater than any one of the mean scores for the laboratory sections taught by the Experimental I, II or III Methods.

Table 23

Planned Comparisons of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction: Winter Term, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,976.59	3	658.86	18.43*****
Contrasts:				
1. Control vs. Exp. I	378.60	1	378.60	10.59****
2. Control vs. Exp. II	1,653.58	1	1,653.58	46.25*****
3. Control vs. Exp. III	987.68	1	987.68	27.63*****
Within	2,073.75	58	35.75	

****Significant at $P < 0.005$ level of probability.

*****Significant at $P < 0.001$ level of probability.

Analysis of variance data for Spring Term 1975, Unit D product summary outlines are presented in Table 24. The calculated F value of 6.61 is significant at the $P < 0.001$ level of probability ($_{.999}F_{3,60} = 6.17$).

Table 24

Comparison of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2	16	94.88	1,518	2,304,324	144,390
I	4	16	90.88	1,454	2,114,116	132,508
II	1	16	90.00	1,400	2,073,600	130,774
III	3	16	84.75	1,356	1,838,736	115,474

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	815.04	3	271.68	6.61*****
Within	2,467.25	60	41.12	

[a] C = Control; I, II, III = Experimental.

*****Significant at $P < 0.001$ level of probability.

Analysis by planned comparisons of contrasts between mean scores for the Control and Experimental I, II or III Methods of instruction yield the F values of Table 25. Only the mean product summary outline scores for the laboratory sections taught by Experimental Methods II and III differ significantly from the mean score for the laboratory section

Table 25

Planned Comparisons of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction: Spring Term, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	815.04	3	271.68	6.61*****
Contrasts:				
1. Control vs. Exp. I	128.00	1	128.00	3.11
2. Control vs. Exp. II	190.52	1	190.52	4.62*
3. Control vs. Exp. III	820.94	1	820.94	19.92*****
Within	2,467.25	60	41.12	

*Significant at $P < 0.05$ level of probability.

*****Significant at $P < 0.001$ level of probability.

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taught by the Control Method. Thus, for Spring Term 1975, it appears that the laboratory section taught by the Control Method achieved a significantly higher mean product summary outline score than did those sections taught by Experimental Methods II or III but did not differ significantly from the laboratory section taught by the Experimental I Method of laboratory instruction.

This discrepancy between Winter and Spring Terms 1975 for the Control vs. Experimental I Contrast does not appear to be attributable to differences in laboratory section composition since the Control groups (Section 3, Winter; Section 2, Spring) and Experimental I groups (Section 2, Winter; Section 4, Spring) were characterized in the sample description as comparable. It should be noted that the F value of 3.11 for the Control vs. Experimental I Contrast of Spring Term did approach significance at $P < 0.05$ level ($_{.950}F_{1,60} = 4.00$).

When the product summary outline data for Laboratory Unit D from the appropriate laboratory sections of Winter and Spring Term were combined and analyzed by one-way ANOVA, Table 26 resulted. The calculated F value of 18.08 exceeds the value of 5.79 ($_{.999}F_{3,122}$) necessary for significance.

Further analysis by use of planned comparisons for the contrasts shown in Table 27 yield significant F values for all three contrasts.

Table 26

Comparison of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3 + 2	32	95.28	3,049	9,296,401	291,083
I	2 + 4	30	89.80	2,694	7,257,636	242,776
II	4 + 1	32	85.41	2,733	7,469,289	235,919
III	1 + 3	32	84.47	2,703	7,306,209	229,659

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	2,342.34	3	780.78	18.08*****
Within	5,268.96	122	43.18	

[a]C = Control; I, II, III = Experimental

*****Significant at $P < 0.001$ level of probability.

According to the analyses for Laboratory Unit D mean product summary outline scores, the achievement of students taught by the Control Method of laboratory instruction significantly exceeded the achievement of comparable students taught by Experimental I, II or III Methods of instruction. From these findings it is apparent that, if applied to this unit of study, none of the experimental instructional methods tested would produce student achievement on the assignment of writing a product summary outline equivalent to or better than the Control Method of laboratory instruction.

Table 27

Planned Comparisons of Laboratory Unit D Product Summary Outline Scores for Four Methods of Instruction: Combined Winter and Spring Terms, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	2,342.34	3	780.78	18.08*****
Contrasts:				
1. Control vs. Exp. I	465.59	1	465.59	10.78****
2. Control vs. Exp. II	1,510.34	1	1,510.34	34.98*****
3. Control vs. Exp. III	1,811.72	1	1,811.72	41.96*****
Within	5,268.96	122	43.18	

****Significant at $P < 0.005$ level of probability.

*****Significant at $P < 0.001$ level of probability.

Laboratory Unit E. Winter Term Laboratory Unit E product summary outline scores were compared by one-way ANOVA to yield an F value of 1.15 which does not exceed the value of 2.76 ($_{.950}F_{3,58}$) necessary for significance (Table 28).

Table 28

Comparison of Laboratory Unit E Product Summary Outline Scores for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1	15	80.07	1,201	1,442,401	97,221
I	3	16	83.81	1,341	1,798,281	113,475
II	2	15	79.80	1,197	1,432,809	96,607
III	4	16	78.31	1,253	1,570,009	99,311

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	262.27	3	87.42	1.15
Within	4,415.22	58	76.12	

[a] C = Control; I, II, III = Experimental.

One-way ANOVA applied to Spring Term (Table 29) and combined Winter and Spring Terms (Table 30) Laboratory Unit E product summary outline data also produce non-significant F values of 1.38 ($_{.950}F_{3,60}=2.76$) and 2.26 ($_{.950}F_{3,122}=2.68$), respectively. Thus, Laboratory Unit E mean product summary outline scores for the laboratory sections taught by

Table 29

Comparison of Laboratory Unit E Product Summary Outline Scores for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3	16	78.44	1,255	1,575,025	100,725
I	2	16	82.88	1,326	1,758,276	110,694
II	4	16	75.19	1,203	1,447,209	92,871
III	1	16	78.63	1,258	1,582,564	100,336

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	447.06	3	159.02	1.38
Within	6,933.88	60	115.56	

[a] C = Control; I, II, III = Experimental.

Table 30

Comparison of Laboratory Unit E Product Summary Outline Scores for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1 + 3	31	79.22	2,456	6,031,936	197,946
I	3 + 2	32	83.34	2,667	7,112,889	224,169
II	2 + 4	31	77.42	2,400	5,760,000	189,478
III	4 + 1	32	78.47	2,511	6,305,121	199,647

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	641.10	3	213.70	2.26
Within	11,542.16	122	94.60	

[a] C = Control; I, II, III = Experimental.

Experimental I, II or III Methods of instruction do not differ significantly from the mean score for the laboratory section taught by the Control Method. Experimental I, II or III Methods of laboratory instruction, therefore, could be substituted for the Control Method within Laboratory Unit E and produce an equivalent level of student achievement on the assignment of writing a product summary outline.

Test of Null Hypothesis: Product Summary Outlines

H_o: The achievement on Product Summary Outlines for Laboratory Study Units B, C, D or E of undergraduate students taught by Experimental Methods I, II or III will not differ significantly from the achievement on Product Summary Outlines for Study Units B, C, D or E of comparable students taught by the Control Method.

Analysis of the product summary outline data by one-way ANOVA and planned comparisons (where applicable) for Laboratory Units B, C, D and E taught by the Control or Experimental I, II or III Methods of laboratory instruction produced F values that substantiate the rejection of H_o. Within Laboratory Units B, C and E, mean product summary outline scores for the laboratory sections taught by Experimental I, II or III Methods of instruction did not differ significantly from the mean scores of the laboratory sections taught by the Control Method. However, significant

differences attributable to method were shown within Laboratory Unit D. For Laboratory Unit D (meats, poultry, fish) it appears that the Control Method of laboratory instruction obtained a significantly higher level of student achievement on product summary outlines than did Experimental I, II or III Methods of laboratory instruction.

Product Evaluations

For three instructional methods (Control, Experimental I and II), product evaluations for selected items were required written assignments for each student for all Laboratory Units of Study (B, C, D and E). Selected products were evaluated qualitatively for volume, external appearance, texture or consistency, tenderness and taste or flavor. The mean product evaluation scores per laboratory unit of study are presented in Table 31.

Student's t was used to determine the significance of differences between the mean product evaluation scores for Experimental Methods I or II as compared to the Control Method of laboratory instruction within all laboratory units of study. The mean product evaluation scores are based on the scores of the same 16 students per laboratory section chosen for product summary outline analyses. Statistical findings for significance of differences in mean product

Table 31

Mean Product Evaluation Scores Per Laboratory Unit of Study for Three Methods of Instruction

Method of Instruction	No. of Students	Laboratory Unit of Study			
		B	C	D	E
Winter, 1975					
Control	16	84.88 ± 6.06[a]	79.88 ± 5.54	73.12 ± 9.98	93.38 ± 3.32
Experimental I	16	85.25 ± 5.70	90.44 ± 3.93	82.19 ± 4.46	98.44 ± 3.01
Experimental II	16	85.75 ± 3.60	80.94 ± 8.14	81.93 ± 4.02	92.44 ± 4.12
Spring, 1975					
Control	16	89.12 ± 3.26	84.62 ± 5.86	88.12 ± 5.53	90.00 ± 4.32
Experimental I	16	87.88 ± 5.62	90.56 ± 4.05	92.00 ± 6.33	94.00 ± 3.44
Experimental II	16	88.12 ± 6.80	87.00 ± 3.57	95.38 ± 6.14	89.00 ± 6.22

[a]Mean ± Standard Deviation.

evaluation scores for each laboratory unit of study for Winter and Spring Terms 1975 are reported in Table 32.

Table 32

Significance of Differences in Mean Product Evaluation Scores Per Laboratory Unit of Study

Term and Comparison	Laboratory Unit of Study			
	B	C	D	E
Winter, 1975				
Control, Experimental I	ns[a]	P < 0.005	P < 0.005	P < 0.005
Control, Experimental II	ns	ns	P < 0.005	ns
Spring, 1975				
Control, Experimental I	ns	P < 0.005	P < 0.025	P < 0.05
Control, Experimental II	ns	ns	P < 0.005	ns

[a]Ns = not significant; determined by Student's t (Hoel, 1966).

Laboratory Unit B. No significant differences between mean product evaluation scores for groups taught by the Control, Experimental I or II Methods of instruction were found for Winter or Spring Terms 1975 (Table 32). Thus, Experimental Methods I or II might be substituted for the Control Method of laboratory instruction and obtain at least equivalent student achievement on product evaluations for Laboratory Unit B.

Laboratory Unit C. Analysis of the data for Laboratory Unit C for both Winter and Spring Terms 1975 demonstrated a significant difference ($P < 0.005$) between the mean product evaluation scores for groups taught by the Control and Experimental I Methods of laboratory instruction but not between the Control and Experimental II Methods (Table 32). For this laboratory unit of study, the Experimental I Method of instruction appears to be superior to the Control and Experimental II Methods of instruction as measured by student achievement on the product evaluations. The Experimental II Method of instruction might be substituted for the Control Method of laboratory instruction and obtain at least equivalent student achievement on product evaluations.

Laboratory Unit D. Analysis of the data for Laboratory Unit D for both Winter and Spring Terms 1975 demonstrated significant differences between the mean product evaluation scores for groups taught by the Control and Experimental I Methods of instruction ($P < 0.005$, Winter; $P < 0.025$, Spring) and between the Control and Experimental II Methods ($P < 0.005$, Winter and Spring) (Table 32). The Experimental I and II Methods of instruction appear to be superior to the Control Method as measured by student achievement on the product evaluations for Laboratory Unit D.

Laboratory Unit E. Analysis of the data for Laboratory Unit E for both Winter and Spring Terms 1975 demonstrated significant differences between the mean product evaluation scores for groups taught by the Control and Experimental I Methods of laboratory instruction ($P < 0.005$, Winter; $P < 0.05$, Spring) but not between the Control and Experimental II Methods (Table 32). The Experimental I Method of laboratory instruction appears to be superior to the Control and Experimental II Methods as measured by student achievement on the product evaluations for Laboratory Unit E. The Experimental II Method of laboratory instruction might be substituted for the Control Method of laboratory instruction and obtain at least equivalent student achievement on product evaluations.

Laboratory Unit Tests

Laboratory unit test scores for the same 16 students per laboratory section chosen for product summary outline and product evaluation analyses were used for comparison. These test scores were tested using one-way ANOVA to yield F ratios for methods. When the F values were statistically significant, planned comparisons were used to determine differences attributable to instructional methods.

A discussion of laboratory unit test reliability and validity precedes the presentation of the ANOVA data

per laboratory unit of study to emphasize their importance to the interpretation of the research findings.

Reliability and validity of laboratory unit tests. Laboratory unit tests constructed by the experimenter and reviewed for content validity by two food specialists were subjected to an item analysis in order to obtain Kuder-Richardson Reliability Coefficients (KR_{20}). These coefficients are detailed in Table 33 according to instructional term and laboratory section number for each laboratory unit test.

Table 33

Kuder-Richardson Reliability (KR_{20}) Coefficients for Laboratory Unit Tests Per Laboratory Unit of Study

Term and Section	No. of Students	Laboratory Unit Tests			
		I--Unit B	II--Unit C	III--Unit D	IV--Unit E
Winter, 1975					
1	16	0.7393	0.6575	0.6961	0.6201
2	18	0.6761	0.7574	0.7085	0.7538
3	21	0.6669	0.7820	0.8148	0.7712
4	20	0.7628	0.6739	0.6601	0.7375
	Average	0.7113	0.7177	0.7199	0.7206
Spring, 1975					
1	18	0.6224	0.6149	0.6784	0.7120
2	21	0.6151	0.7410	0.7201	0.6599
3	21	0.7538	0.7945	0.7538	0.7095
4	18	0.6742	0.6853	0.6369	0.6531
	Average	0.6664	0.7089	0.6973	0.6836
Difference		0.0449	0.0088	0.0226	0.0370

The variability between KR_{20} coefficients within and among the laboratory units of study was found to be small. The average reliability coefficient per laboratory unit of study ranged from 0.6664 (Laboratory Unit B, Spring Term) to 0.7206 (Laboratory Unit E, Winter Term) and was considered an acceptable level since each Laboratory Unit Test (I, II, III and IV) was restricted to 35 to 40 questions per 30 minute examination period. The extent of reliability and the validity established for the laboratory unit tests permit greater confidence in the accuracy of the test scores for statistical comparisons.

Laboratory Unit B. Analysis of variance data for Winter Term 1975 Laboratory Test I scores are presented in Table 34. The calculated F value of 0.19 does not exceed the value of 2.76 ($_{.950}F_{3,59}$) required for significance.

Tables 35 (Spring Term) and 36 (Combined Winter and Spring Terms) also present non-significant F values of 0.20 ($_{.950}F_{3,60} = 2.76$) and 0.21 ($_{.950}F_{3,124} = 2.68$), respectively.

There are, therefore, no significant differences in Test I (Unit B) scores for laboratory sections taught by the Control, Experimental I, II or III Methods of instruction. Any one of the three experimental instructional methods tested could be applied to Laboratory Unit B and obtain the same level of student achievement on an equivalent unit test as by the Control Method of laboratory instruction.

Table 34

Comparison of Laboratory Test I Scores (Unit B) for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4	16	78.19	1,251	1,565,001	99,135
I	1	16	75.25	1,204	1,449,616	92,996
II	3	16	76.62	1,226	1,503,076	95,918
III	2	16	76.88	1,230	1,512,900	95,892

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	66.00	3	22.00	0.19
Within	7,013.00	60	116.88	

[a] C = Control; I, II, III = Experimental.

Table 35

Comparison of Laboratory Test I Scores (Unit B) for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1	16	77.06	1,233	1,520,289	96,321
I	3	16	77.25	1,236	1,527,696	97,672
II	2	16	75.25	1,204	1,449,616	92,070
III	4	16	77.75	1,244	1,547,536	97,412

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	57.17	3	19.05	0.20
Within	5,653.94	60	94.23	

[a] C = Control; I, II, III = Experimental.

Table 36

Comparison of Laboratory Test I Scores (Unit B) for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4 + 1	32	77.62	2,484	6,170,256	195,456
I	1 + 3	32	76.25	2,440	5,953,600	190,668
II	3 + 2	32	75.94	2,430	5,904,900	187,988
III	2 + 4	32	77.31	2,474	6,120,676	193,304

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	63.62	3	21.20	0.21
Within	12,746.26	124	102.79	

[a] C = Control; I, II, III = Experimental.

Laboratory Unit C. Table 37 presents the ANOVA data for Winter Term 1975 Laboratory Test II scores (Unit C). The calculated F value of 3.35 does exceed the value of 2.76 ($_{.950}F_{3,59}$) required for significance.

Since the F value of 3.35 (Table 37) is significant a difference does exist among the mean scores on Laboratory Test II (Unit C) for the laboratory sections taught by the Control, Experimental I, II or III instructional methods.

The planned comparisons method of analysis was used to determine where these differences in mean scores occurred. F values for the contrasts of mean test scores for Experimental I, II and III Methods to the mean score for the Control Method are reported in Table 38.

Table 37

Comparison of Laboratory Test II Scores (Unit C) for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2	16	74.07	1,111	1,234,321	84,815
I	4	16	78.44	1,255	1,575,025	99,895
II	1	16	70.44	1,127	1,270,129	80,853
III	3	16	82.25	1,316	1,731,856	110,178

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,264.18	3	421.39	3.35*
Within	7,419.82	59	125.75	

[a]C = Control; I, II, III = Experimental.

*Significant at $P < 0.05$ level of probability.

Only contrast three (Control vs. Experimental III) produced a significant F value ($P < 0.05$). The data in Table 38 may be interpreted as follows: Winter Term Laboratory Test II mean scores for laboratory sections taught by Experimental Methods I and II do not differ significantly from the mean test score for the laboratory section taught by the Control Method, while the mean test score for the laboratory section taught by Experimental Method III is significantly higher than the mean score for the Control Method group. In Laboratory Unit C one could therefore substitute Experimental Methods I, II or III for

Table 38

Planned Comparisons of Laboratory Test II Scores (Unit C) for Four Methods of Instruction: Winter Term, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,264.18	3	421.39	3.35*
Contrasts:				
1. Control vs. Experimental I	148.04	1	148.04	1.17
2. Control vs. Experimental II	102.15	1	102.15	0.81
3. Control vs. Experimental III	518.70	1	518.70	4.12*
Within	7,419	59	125.75	

*Significant at $P < 0.05$ level of probability.

the Control Method and achieve equivalent results by Experimental Methods I and II and even better results by Experimental Method III.

Analysis of variance data for Spring Term 1975 Laboratory Test II scores (Unit C) are presented in Table 39. The calculated F value of 0.86 does not exceed the value of 2.76 ($_{.950}F_{3,60}$) required for significance.

Table 39

Comparison of Laboratory Test II Scores (Unit C) for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	4	16	79.75	1,276	1,628,176	102,928
I	1	16	77.75	1,244	1,547,536	98,026
II	3	16	76.50	1,224	1,498,176	97,396
III	2	16	82.56	1,321	1,745,041	110,593

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	335.80	3	111.93	0.86
Within	7,759.94	60	129.33	

[a] C = Control; I, II, III = Experimental.

When Laboratory Test II scores (Unit C) for Winter and Spring Terms 1975 were combined by appropriate laboratory sections and analyzed by one-way ANOVA, the data in Table 40 were obtained. The calculated F value of 4.34

Table 40

Comparison of Laboratory Test II Scores (Unit C) for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2 + 4	31	77.00	2,387	5,697,769	187,743
I	4 + 1	32	78.09	2,499	6,245,001	197,921
II	1 + 3	32	73.47	2,351	5,527,201	174,849
III	3 + 2	32	82.40	2,637	6,953,769	220,771

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,301.53	3	433.84	4.34***
Within	12,298.41	123	99.98	

[a] C = Control; I, II, III = Experimental

***Significant at $P < 0.01$ level of probability.

is significant at the $P < 0.01$ level of probability ($_{.990}F_{3,123} = 3.95$).

Analysis by planned comparisons of the contrasts between mean test scores for the Control and Experimental I, II or III Methods of instruction yield the F values reported in Table 41. The same findings as for Winter Term 1975 were evidenced. Mean Laboratory Test II scores for the laboratory sections taught by Experimental I or II Methods did not differ significantly from the mean score obtained by the Control Method group, while the mean test score for the

Table 41

Planned Comparisons of Laboratory Test II Scores (Unit C) for Four Methods of Instruction: Combined Winter and Spring Terms, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	1,301.53	3	433.84	4.34***
Contrasts:				
1. Control vs. Experimental I	18.89	1	18.89	0.19
2. Control vs. Experimental II	197.78	1	197.78	1.97
3. Control vs. Experimental III	462.86	1	462.86	4.63*
Within	12,298.41	123	99.98	

*Significant at $P < 0.05$ level of probability.

***Significant at $P < 0.01$ level of probability.

Experimental III Method group was significantly higher than the mean score for the laboratory section taught by the Control Method.

Based on the analyses for Winter, Spring, and combined Winter and Spring Terms, 1975, it appears that Experimental I or II Methods of laboratory instruction could be substituted for the Control Method and achieve equivalent results as measured by mean scores on a laboratory unit test, while Experimental Method III could probably produce greater achievement than the Control Method on a comparable Laboratory Unit C Test.

Laboratory Unit D. Winter Term Laboratory Test III scores (Unit D) were compared by one-way ANOVA to yield an F value of 3.82 (Table 42). Since this value exceeds the critical value of 2.76 ($_{.950}F_{3,60}$), the mean test scores for the laboratory sections taught by the Control, Experimental I, II and III Methods of laboratory instruction do differ significantly.

The planned comparisons analysis used to contrast Laboratory Test III mean scores (Unit D) for groups taught by Experimental Methods I, II and III to the mean score for the group taught by the Control Method is detailed in Table 43.

Table 42

Comparison of Laboratory Test III Scores (Unit D) for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3	16	90.94	1,455	2,117,025	133,611
I	2	16	92.31	1,477	2,181,529	136,777
II	4	16	88.94	1,423	2,024,929	127,099
III	1	16	84.25	1,348	1,817,104	114,420

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	595.92	3	198.64	3.82**
Within	3,120.32	60	52.00	

[a]C = Control; I, II, III = Experimental.

**Significant at $P < 0.025$ level of probability.

The F value of 6.94 for contrast three (Control vs. Experimental III) was significant at $P < 0.025$ level of probability ($_{.975}F_{1,60} = 5.29$). The Laboratory Test III mean score (Unit D) for the Experimental Method III group was significantly smaller than the mean score for the Control Method group but Laboratory Test III mean scores (Unit D) for the laboratory sections taught by Experimental I and II Methods did not differ significantly from the mean score for the Control Method group.

One-way ANOVA applied to Spring Term (Table 44) and combined Winter and Spring Terms (Table 45) Laboratory Test

Table 43

Planned Comparisons of Laboratory Test III Scores (Unit D) for Four Methods of Instruction: Winter Term, 1975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	595.92	3	198.64	3.82**
Contrasts:				
1. Control vs. Experimental I	15.14	1	15.14	0.29
2. Control vs. Experimental II	32.26	1	32.26	0.62
3. Control vs. Experimental III	360.94	1	360.94	6.94**
Within	3,120.32	60	52.00	

**Significant at $P < 0.025$ level of probability.

Table 44

Comparison of Laboratory Test III Scores (Unit D) for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	2	16	88.00	1,408	1,982,464	125,334
I	4	16	89.75	1,436	2,062,096	129,376
II	1	16	86.12	1,378	1,898,884	120,674
III	3	16	88.19	1,411	1,990,921	125,805

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	105.80	3	35.26	0.40
Within	5,291.19	60	88.18	

[a] C = Control; I, II, III = Experimental.

Table 45

Comparison of Laboratory Test III Scores (Unit D) for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3 + 2	32	89.47	2,863	8,196,769	258,945
I	2 + 4	32	91.03	2,913	8,485,569	266,153
II	4 + 1	32	87.53	2,801	7,845,601	247,773
III	1 + 3	32	86.22	2,759	7,612,081	240,225

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	473.20	3	157.73	2.26
Within	8,678.26	124	69.98	

[a] C = Control; I, II, III = Experimental.

III scores (Unit D) produced non-significant F values of 0.40 ($_{.950}F_{3,60} = 2.76$) and 2.26 ($_{.950}F_{3,124} = 2.68$), respectively.

The significant difference between Experimental Method III and the Control Method for Laboratory Test III scores (Unit D) found during Winter Term was not evidenced Spring Term nor when Winter and Spring Term test data were combined for analysis. Findings from the analyses for this unit of study indicate that Experimental I, II or III Methods of laboratory instruction could be substituted for the Control Method and produce an equivalent level of student achievement on a comparable laboratory unit test.

Laboratory Unit E. One-way ANOVA applied to Winter Term (Table 46), Spring Term (Table 47) and combined Winter and Spring Term (Table 48) Laboratory Test IV scores (Unit E) produced non-significant F values of 1.46 ($_{.950}F_{3,60} = 2.76$), 1.86 ($_{.950}F_{3,60} = 2.76$) and 2.28 ($_{.950}F_{3,124} = 2.68$), respectively. Laboratory Test IV mean scores (Unit E) for laboratory sections taught by Experimental I, II or III Methods of instruction do not differ significantly from the mean scores for the laboratory sections taught by the Control Method. Therefore, Experimental I, II or III Methods of laboratory instruction could be substituted for the Control Method within Laboratory Unit E and produce an equivalent level of student achievement on a comparable laboratory unit test.

Table 46

Comparison of Laboratory Test IV Scores (Unit E) for Four Methods of Instruction:[a] Winter Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1	16	76.62	1,226	1,503,076	95,840
I	3	16	83.31	1,333	1,776,889	113,089
II	2	16	82.12	1,314	1,726,596	109,384
III	4	16	77.69	1,243	1,545,049	98,301

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	515.37	3	171.79	1.46
Within	7,038.38	60	117.30	

[a] C = Control; I, II, III = Experimental.

Table 47

Comparison of Laboratory Test IV Scores (Unit E) for Four Methods of Instruction:[a] Spring Term, 1975

Inst. Meth.	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	3	16	82.25	1,316	1,731,856	109,720
I	2	16	80.50	1,288	1,658,944	105,070
II	4	16	82.00	1,312	1,721,344	108,608
III	1	16	74.94	1,199	1,437,601	91,975

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	558.67	3	186.22	1.86
Within	6,013.94	60	100.23	

[a] C = Control; I, II, III = Experimental.

Table 48

Comparison of Laboratory Test IV Scores (Unit E) for Four Methods of Instruction:[a] Combined Winter and Spring Terms, 1975

Inst. Meth.	Lab. Sec. W + S	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C	1 + 3	32	79.44	2,542	6,461,764	205,560
I	3 + 2	32	81.91	2,621	6,869,641	218,159
II	2 + 4	32	82.06	2,626	6,895,876	217,992
III	4 + 1	32	76.31	2,442	5,963,364	190,176

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	738.08	3	246.02	2.28
Within	13,388.30	124	107.97	

[a] C = Control; I, II, III = Experimental.

Test of Null Hypothesis: Laboratory Unit Tests

H_o: The achievement on Laboratory Test I (Study Unit B), Laboratory Test II (Study Unit C), Laboratory Test III (Study Unit D) and Laboratory Test IV (Study Unit E) of undergraduate students taught by Experimental Methods I, II or III will not differ significantly from the achievement on Laboratory Tests I, II, III or IV of comparable students taught by the Control Method.

Analysis of the Laboratory Test I, II, III and IV data by one-way ANOVA and planned comparisons (where applicable) for Laboratory Units B, C, D and E taught by the Control or Experimental I, II or III Methods of instruction produced F values that substantiate the rejection of H_o.

Within Laboratory Units B, D and E, mean scores on Laboratory Tests I, III and IV, respectively, for laboratory sections taught by Experimental I, II or III Methods of instruction did not differ significantly from laboratory sections taught by the Control Method. However, a significant difference attributable to method was detected in Laboratory Unit C. From the Laboratory Test II (Unit C) analyses for Winter, Spring and combined Winter and Spring Terms 1975, it appears that Experimental I or II Methods of laboratory instruction could be substituted for the Control Method and achieve equivalent results, whereas Experimental Method III could probably produce greater achievement than the Control Method on an equivalent laboratory unit test.

Test of Operational Null Hypothesis 1

H_o: The achievement of undergraduate students in the laboratory portion of an elementary food preparation course taught by Experimental Methods I, II or III will not differ significantly from the achievement of comparable students taught by the Control Method for Laboratory Study Units B, C, D or E.

Rejection of the previous two null hypotheses (product summary outlines and laboratory unit tests) substantiates the rejection of the operational null hypothesis stated above. For Laboratory Unit D, the Control Method of instruction obtained a significantly higher level of

achievement on product summary outlines than was evidenced by Experimental I, II or III Methods. Within Laboratory Unit C, the Experimental III Method of instruction produced significantly higher achievement than the Control, Experimental I or II Methods of instruction on Laboratory Test II. From these findings it is apparent that student achievement levels in the laboratory portion of an elementary food preparation course may be influenced significantly by the method of laboratory instruction used for some laboratory units of study.

Final Laboratory Examination

One-way ANOVA applied to Winter Term (Table 49) and Spring Term (Table 50) final laboratory examination scores (data from the same 16 subjects per laboratory section used for previous analyses) produced non-significant F values of 2.62 ($_{.950}F_{3,60} = 2.76$) and 1.32 ($_{.950}F_{3,60} = 2.76$), respectively. Student achievement on the final laboratory examination, therefore, did not differ significantly among the four laboratory sections (either Winter Term or Spring Term 1975) taught by four different instructional method sequences. Within the limitations of these data it appears that instructional method sequence does not adversely affect student achievement on the final laboratory examination for this course.

Table 49

Comparison of Laboratory Final Examination Scores Per Laboratory Section: Winter Term, 1975

Inst. Method Sequence[a]	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
I,II,III,C	1	16	86.81	1,389	1,929,321	120,863
III,C,I,II	2	16	88.00	1,408	1,982,464	124,498
II,III,C,I	3	16	91.25	1,460	2,131,600	133,304
C,I,II,III	4	16	87.94	1,407	1,979,649	124,113

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	175.62	3	58.54	2.62
Within	1,338.38	60	22.31	

[a]C = Control; I, II, III = Experimental.

Table 50

Comparison of Laboratory Final Examination Scores Per Laboratory Section: Spring Term, 1975

Inst. Method Sequence[a]	Lab. Sec.	No. of Students	Mean Score	Sum of Scores	Sum of Scores Squared	Sum of Squared Scores
C,I,II,III	1	16	85.69	1,371	1,879,641	118,549
II,III,C,I	2	16	87.19	1,395	1,946,025	121,865
I,II,III,C	3	16	87.81	1,405	1,974,025	123,465
III,C,I,II	4	16	84.63	1,354	1,833,316	114,792

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Between	105.66	3	35.22	1.32
Within	1,602.45	60	26.71	

[a]Control; I, II, III = Experimental.

Test of Operational Null Hypothesis 2

H_o: The achievement of undergraduate students on the Final Laboratory Examination for an elementary food preparation course will not differ significantly among four laboratory sections taught by four different instructional method sequences.

After the determination that the F values of Tables 49 and 50 were not significant, the null hypothesis stated above is not rejected. As measured by the final laboratory examination scores, there were no significant differences in student achievement among the four laboratory sections taught by four different instructional method sequences for either Winter Term or Spring Term 1975.

Student Attitudinal Information

This section summarizes and presents a discussion of student responses on four laboratory study unit reactionnaires and the final laboratory evaluation. In all cases, the student response data from Winter and Spring Terms 1975 were combined and reflect the attitudes of all participants with corresponding assignments.

Laboratory Study Unit Reactionnaires

At the conclusion of Laboratory Units B, C, D, and E, students were asked to complete a two-page evaluation form (Appendix C) designed to elicit their reactions to the

instructional method used for the specific unit of laboratory work. Student reactions to a series of structured statements that were combined into the six categories shown in Table 51 are reported and discussed first. The mean extent of agreement or favorableness was determined by weighting individual responses from one to five (least to most) and then calculating the mean values for the categories.

Following this, student personal comments on four general open-ended questions about the laboratory activities for the study unit, the method of instruction used and the quality of learning realized are presented and discussed. The student comments reported were arrived at by recording student comments for each open-ended question and then summarizing the most frequently listed ideas.

As shown in Table 51, each of the four laboratory instructional methods received mean rank scores of 3.61 or better for each laboratory unit of study (B, C, D, E) on clarity of lesson objectives and directions. In each laboratory unit of study all three Experimental Methods (I, II, III) ranked higher than did the Control Method for this category with the Experimental III Method consistently receiving the highest rank across all units of study.

Table 51

Comparison of Mean Rank Scores on Laboratory Study Unit Reactionnaires

Category	Laboratory Unit of Study															
	B				C				D				E			
	Method of Laboratory Instruction[a]															
	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III
Clarity of lesson objectives and directions:																
1, 6, 11, 14[b]	3.62±[d]	4.00±	3.99±	4.01±	3.64±	3.72±	4.04±	4.06±	3.61±	3.79±	3.86±	3.91±	3.62±	3.80±	3.89±	3.93±
1, 7, 13, 17, 18[c]	0.17	0.13	0.47	0.36	0.34	0.28	0.37	0.38	0.22	0.18	0.50	0.18	0.19	0.20	0.42	0.41
Topic organization and continuity:																
2, 2, 4, 5, 10	3.53±	3.97±	3.50±	3.69±	3.58±	3.99±	3.63±	3.84±	3.36±	3.71±	3.52±	3.48±	3.80±	3.84±	3.28±	3.44±
2, 3, 4, 5, 6, 8, 12	0.31	0.16	0.47	0.43	0.35	0.43	0.30	0.38	0.38	0.30	0.52	0.51	0.29	0.24	0.50	0.39
Rate of presentation:																
9	3.00	3.91	2.31	2.34	3.10	2.94	2.31	2.21	2.74	3.35	1.96	1.67	3.52	3.25	1.94	2.56
11	--[e]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Terminology and example products used to illustrate principles:																
7, 8	3.70±	4.10±	3.80±	3.76±	4.08±	3.66	3.72±	4.14±	3.92±	4.04±	3.96±	3.86±	3.96±	4.04±	3.70±	4.08±
9, 10	0.31	0.34	0.00	0.04	0.14	0.26	0.08	0.10	0.03	0.10	0.18	0.10	0.14	0.22	0.10	0.24
Overall quality of instructional method:																
12	3.82	4.18	3.52±	3.65	3.48	3.83	3.60	3.79	3.47	3.94	3.30	3.27	3.84	3.88	3.32	3.56
15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Development of positive interest in the subject matter:																
13	4.68	4.09	4.16±	4.00±	4.20	4.03	3.90±	3.91±	3.95	3.84	3.56±	3.56±	4.03	3.90	3.52±	3.75±
14, 16	--	--	0.36	0.45	--	--	0.19	0.09	--	--	0.09	0.08	--	--	0.18	0.16

[a] C = Control; I, II, III = Experimental.

[b] Reactionnaire item numbers used to calculate mean scores for Control and Experimental I Methods of instruction.

[c] Reactionnaire item numbers used to calculate mean scores for Experimental II and Experimental III Methods of instruction

[d] Mean ± Standard Deviation; 5 = highest score possible (scale = 1 to 5).

[e] Calculation based on mean for one item.

For topic organization and continuity each of the four methods of instruction received a mean rank score of 3.28 or better for each laboratory unit of study. In this instance Experimental Method I consistently ranked higher than any other method (Control, Experimental II or III) across all units of study.

Students consistently ranked Experimental II and III Methods of laboratory instruction lower than the Control and Experimental I Methods on rate of presentation. This was due, in part, to the rapid rate of narration on recorded tapes as compared to in-class verbalization where students could stop the instructor periodically and request further explanations of processes or procedures. The Control Method had the highest mean rank scores for Laboratory Units C and E (3.10 and 3.52) while Experimental Method I ranked highest for Units B and D (3.91 and 3.35).

Each of the four instructional methods had mean rank scores of 3.66 or better for terminology and example products used to illustrate principles for each laboratory unit of study. The Experimental I Method ranked highest for Laboratory Units B (4.10) and D (4.04) while the Experimental III Method ranked highest for Laboratory Units C (4.14) and E (4.08).

The highest rank on overall quality of instructional method was consistently received by Experimental Method I

across all laboratory units of study. No instructional method received a mean rank of less than 3.27 for any laboratory unit of study.

For the last category, development of positive interest in the subject matter, the Control Method received the highest rank across all units of study (B, C, D, E). Each of the four instructional methods had mean scores of 3.52 or better for each laboratory unit of study.

After responding to the questions related to the six categories above, students were asked for personal comments on four general open-ended items. Responses to each of these open-ended questions (in italics) are summarized for each method of laboratory instruction across the four laboratory units of study.

Please summarize in one sentence your overall reaction to the unit of study.

Responses--Laboratory Units B, C, D, E.

Control: Hands-on-experiences of food preparation are most beneficial to the student. Laboratory concepts relate well to the lecture topics.

Exp. I: This method of instruction is informative, interesting, enjoyable and well organized, but students need hands-on-experiences in food preparation.

Exp. II: This method of instruction is enjoyable, interesting, and informative, and working at one's own pace is an advantage. The only adverse note is having to switch from demonstration techniques to independent study in the middle of a unit of study.

Exp. III: The rate of presentation for this method of instruction is far too fast but it is an excellent means to be sure one records all the principles of preparation for a product. The major complaint is the lack of hands-on-experience in preparation.

For all laboratory units of study (B, C, D, E) the student responses could be summarized into the statements presented above. It appears, therefore, that even when the laboratory study units are quite different in content the overall attitudes or opinions of students toward each of the four laboratory instructional methods remain the same.

In one sentence, state what you believe to be the best or most interesting feature of the unit of study just completed.

Responses--Laboratory Units B, C, D, E.

Control: The actual preparation of a large variety of products, the techniques learned, and product evaluations are the best features.

Exp. I: Observation of the correct methods of preparation, time to ask questions or take notes and the time saving factor of everyone not having to prepare a product are most beneficial to the student.

Exp. II: The presentation of principles is very complete but one cannot ask the instructor questions during independent study laboratories. It is very confusing to switch from demonstration techniques to independent study in the middle of a unit of study.

Exp. III: This method of instruction provides all the information in a precise, well organized manner, but the rate of presentation is too fast and one cannot ask the instructor questions.

Again, for all laboratory units of study (B, C, D, E), the student responses could be summarized according to a method of instruction. The best or most interesting features of the unit of study were perceived by the student as being synonymous with the instructional method, not the subject matter content. The instructional method, therefore, greatly influences student attitudes toward the subject matter to be learned.

Were any lessons in this unit of study not suitable to the method of presentation used? If so, which one(s)? Why?

Responses--Laboratory Units B, C, D, E.

Control: No.

Exp. I: No.

Exp. II: No.

Exp. III: No.

Within each laboratory unit of study all lessons were thought to be appropriately taught by any of the four methods of instruction.

Write below any suggestions that you believe will improve the unit of study.

Response--Laboratory Unit B.

Control: Give better and more complete presentations of principles of preparation, cover less material, and slow down the rate of presentation.

Exp. I: Students should prepare their own products. Don't have so many demonstrations in a row.

Exp. II: Use independent study modules only as a review. Let student prepare their own products.

Exp. III: Students should prepare products after viewing the slide-tape presentation.

Response--Laboratory Unit C.

Control: Reduce the number of items prepared within one laboratory lesson. Incorporate independent study as a supplement or review.

Exp. I: Students should prepare products themselves. Slow down the pace of the presentation.

Exp. II: Slow down the rate of presentation of the slide-tape lessons. Have student preparation of products in addition to independent study.

Exp. III: Slow down the rate of presentation, and have student preparation of products in addition to the independent study.

Response--Laboratory Unit D.

Control: Spend more time on the principles of preparation and use independent study as a review.

Exp. I: Students should prepare more products themselves and use independent study as a review.

Exp. II: Use the independent study materials for students to prepare themselves before actually preparing products in the laboratory.

Exp. III: Use the independent study materials as a review for the actual student product preparation laboratories.

Response--Laboratory Unit E.

Control: None

Exp. I: Incorporate more time for product evaluations. Use the independent study materials as preparation before coming to the laboratory to prepare products.

Exp. II: None.

Exp. III: Use the independent study materials to supplement the product preparation laboratories.

The overwhelming student response on this last question indicates that students would have preferred to have the independent study materials used for supplementary and/or review purposes with all laboratory sessions taught by the Control Method of instruction. Students liked the instructor demonstrations (Experimental I Method) but wanted only short explanatory demonstrations before actual student preparation of products (Control Method), not entire laboratory sessions by only instructor demonstrations.

Final Laboratory Evaluation

This instrument was designed to ascertain student reactions concerning the comparative merits of the four laboratory instructional methods tested in relation to learning effectiveness among Laboratory Study Units B, C, D and E (Evaluation form can be found in Appendix C). First, the student was asked to rank the laboratory instructional methods from one to four (most to least) on completeness of presentation of instructional information. If a student perceived two or more methods as totally equivalent in quality, each could be given the same score. Table 52 presents this tabulated information (responses from 140 of the 153 students enrolled).

Table 52

Laboratory Instructional Methods Ranked on Completeness of Presentation of Instructional Information: Final Laboratory Evaluation

Laboratory Method of Instruction	Rankings[a]				Final Rank
	1	2	3	4	
Control: Student preparation and evaluation of products	75[b]	27	17	19	1
Exp. I: Instructor demonstration and student evaluation of instructor prepared products	24	48[b]	34	30	2
Exp. II: Instructor demonstration and student evaluation of instructor prepared products plus independent study	17	27	65[b]	30	3
Exp. III: Slide-tape presentations (independent study)	30	50[b]	21	28	2

[a]One to four (most to least).

[b]Largest composite score for ranking of each instructional method from combined Winter and Spring Terms, 1975, student responses.

The Control Method of instruction received the greatest number of student responses for the Rank 1 position. Experimental Methods I and III received 48 and 50 votes, respectively, and therefore share the largest number of student responses for the Rank 2 position, while Experimental Method II ranked lowest (Rank 3) in relation to all other methods of laboratory instruction.

Next, the students were asked to indicate which instructional method or combination of methods he/she felt

was best suited for the instruction of Unit B, Unit C, Unit D and Unit E. If a combination of methods was listed, each was recorded as a separate vote not as an actual combination. This instruction, for a student to indicate a combination of methods if he/she thought them complementary, was done to gain more information on each method of laboratory instruction since at this point it was evident that most students highly favored the Control Method (actual food preparation), no matter what its difficulties, in order to do what they referred to as "obtain hands-on-experience." Table 53 shows these student responses (information from 140 of 153 students enrolled) per laboratory unit of study for each laboratory instructional method.

As predicted, the Control Method received the highest number of votes for three of the four laboratory units of study (B, D and E). Experimental Method III ranked the highest for Laboratory Unit C but by only eight votes more than the Control Method. Examination of the data for Experimental Methods I and III across all laboratory units of study reveals that these two methods are almost equally liked among the units of study, and are recommended (by the magnitude of the points they received) as complements or supplements to the Control Method. Experimental Method II received only one-fourth to one-half as many votes as did the other methods and does not appear to be acceptable to

Table 53

Laboratory Instructional Method or Combination of Methods Best Suited for Instruction of Laboratory Units of Study: Final Laboratory Evaluation

Laboratory Unit of Study	Laboratory Instructional Method				Best Instructional Method
	Control	Exp. I	Exp. II	Exp. III	
B: Bake unit (quick breads, cakes)	90[a]	40	19	34	Control
C: Starch, eggs, and custards, egg foam products, milk and cheese	51	40	21	59[a]	Exp. III
D: Meats, fish, poultry	60[a]	40	21	48	Control
E: Vegetables, fruits, gelatin, salads, mayonnaise	52[a]	41	20	40	Control

[a]Largest composite score for laboratory instructional method per laboratory unit of study.

the students. This was probably due to confusion (cited by students on the Laboratory Unit Reactionnaires) caused by switching from instructor demonstration lessons to independent study lessons in the middle of a unit of study.

The next portion of the final laboratory evaluation contained five open-ended questions that asked for a comparison of the amounts of learning realized from the different instructional methods. Yes or no responses to each of these open-ended questions are summarized in the following descriptions.

After observing the slides and listening to the explanations on the tapes, did you feel that, given a basic recipe, you had the knowledge to prepare the products? (Yes or No) Explain your answer.

Yes: 107 students (76.4%)

Comments: The steps in preparation, principles of preparation and techniques used are fully and clearly explained. The product preparations would not just be trial and error.

No: 33 students (23.6%)

Comments: No method of instruction is as clear as actual preparation (Control Method). Confidence in preparation is highly related to hands-on-experiences.

How would you feel about taking the laboratory portion of a foods preparation course entirely by independent study (Experimental III Method)? Comment briefly.

Yes: 22 students (15.7%)

Comments: This method of instruction makes it easier to gain more total information while working at one's own pace. The independent study units need to be slower with more repetition of important points. This is especially good for people with previous food preparation experience.

No: 118 students (84.3%)

Comments: Independent study materials teach principles but not actual preparation techniques and eliminate the important element of student-instructor interaction. Boredom would be a large factor.

Could you have learned as much or more by the slide-tape method (Experimental III Method) as by actual preparation of the products? Comment briefly.

Yes: 75 students (53.6%)

Comments: Important principles are usually left out during actual preparation (Control) laboratories due to a large number of products for only a limited amount of time and this is not true for independent study lessons (Experimental III Method).

No: 65 students (46.4%)

Comments: It is better to learn through mistakes and actual experiences in order to gain confidence and the necessary skills to prepare all types of products.

How would you feel about taking the laboratory portion of a foods preparation course entirely by instructor demonstration and student evaluation of instructor prepared products (Experimental I Method)? Comment briefly.

Yes: 46 students (32.9%)

Comments: With this method, students can take notes and watch the correct techniques at the same time, but, students should take part in the demonstrations.

No: 94 students (67.1%)

Comments: This is a boring method; besides, students need actual hands-on-experiences to gain confidence in their own skills.

Could you have learned as much or more by the instructor demonstration and student evaluation method (Experimental I Method) for the entire course as by actual preparation (Control Method) of products? Comment briefly.

Yes: 65 students (46.4%)

Comments: The instructor demonstration method (Experimental I Method) allows each student to see all the products prepared and this is not true in the actual preparation laboratories (Control Method). The instructor demonstration method would become boring after five or six lessons.

No.: 75 students (53.6%)

Comments: More information is always learned by the actual preparation of products.

From these pro and con comments, it is evident again that students prefer the Control Method of laboratory instruction over Experimental Methods, I, II and III. It is a significant point that students recognize the instructional value of independent study and demonstration techniques, although these methods are not preferred by students for the instruction of an entire laboratory portion of a foods preparation course.

The last item on the final laboratory evaluation asked each student to rate himself/herself again on the amount of previous food preparation experience he/she had had prior to enrollment in HNF 100. The tabulated responses are recorded in Table 54.

Table 54

Amount of Previous Food Preparation Experience of Respondents

Item	Number of Responses	Percentage (%)
Quite a lot	38	27.14
Some	56	40.00
Very little	31	22.14
None	15	10.72
Total	140	100.00

Students rated themselves rather high compared to findings at the beginning of the course (Table 11) where 72.5 percent of the students per laboratory section indicated they had had no previous food preparation experience and only 14 percent or less per laboratory section indicated they had had quite a lot.

Although it is conceivable that after taking HNF 100 these students over-rated their previous food preparation experience, perhaps they recognized their limitations and, therefore, realistically favored actual food preparation experiences within the laboratory over the independent study and/or instructor demonstration methods of laboratory instruction tested.

Test of Operational Null Hypothesis 3

H_o: The attitudes of undergraduate students in the laboratory portion of an elementary food preparation course taught by Experimental Methods I, II or III will not be equivalent to nor more favorable than the attitudes of comparable students taught by the Control Method for Laboratory Study Units B, C, D or E.

The attitudinal data presented allow rejection of H_o. Experimental Method III of laboratory instruction ranked highest across all units of laboratory study for clarity of lesson objectives and directions. The Experimental Method I ranked highest for (a) topic organization

and continuity across all units of study, (b) Units B and D on rate of presentation and on terminology and example products used to illustrate principles, and (c) for overall quality of instructional method across all the units of study. Thus, these instances and others cited in the discussion of the attitudinal data show that attitudes of the students taught by Experimental Methods I, II or III on several occasions are equivalent to or more favorable than the attitudes of comparable students taught by the Control Method of laboratory instruction.

Time Involvement Records

Student achievement, performance and attitudes are major items of concern for any instructional effort, but by no means are they the only concerns of educators involved in the facilitation of student learning. The amount of time required for students to complete individual units of subject matter and the time required of instructional and non-instructional staff to execute the many tasks associated with the instruction of a course are equally important and essential considerations.

For this research study, time involvement records for student, instructional staff and non-instructional staff activities related to the laboratory portion of HNF 100, were compiled for analysis.

Students

Individual student time records (check-in, check-out and total time) were kept for all independent study laboratory sessions taught by Experimental Methods II and III. The average amount of time required per student to complete a lesson taught by independent study within a laboratory unit of study was calculated (Table 55).

Table 55

Average Amount of Time Required Per Student to Complete a Lesson Taught by Independent Study Within a Laboratory Unit of Study

Lab. Unit of Study	Experimental Method II[a]			Experimental Method III		
	Winter 1975 (minutes)	Spring 1975 (minutes)	Number of Lessons	Winter 1975 (minutes)	Spring 1975 (minutes)	Number of Lessons
B	53.40[b]	55.54	2	59.24	58.60	4
C	40.12	40.22	2	48.23	44.55	4
D	57.95	47.75	1	65.54	47.56	2
E	51.42	57.12	2	68.46	48.56	3

[a]Independent study sessions only.

[b]Mean time per lesson.

A single lesson (one laboratory session) within Laboratory Units B, C, D or E, on the average, required 40.12 to 68.46 minutes per student for completion of the independent study module. As a comparison, lessons taught by the Control or Experimental I Methods of laboratory instruction required a total of 110 minutes per lesson for completion. The differences between independent study and demonstration or actual preparation laboratories of 69.80 to 41.54 minutes, can be attributed to activities such as (a) directions given by the instructor, (b) preparation procedures, (c) baking, and (d) clean-up required when products are prepared by either students or the instructor and then evaluated by students in the laboratory. Although these activities are vital to a successful Control or Experimental I Method of laboratory instruction, they are not always the most efficient use of student and/or instructor time.

Instructional Staff

The instructional staff time devoted to each of three types of laboratory associated activities was estimated, recorded and summarized.

Pre-preparations essential for instructor demonstrations. The amount of time required for the pre-preparation of items that were too complicated for complete preparation in the actual demonstration period

was recorded for each lesson within a laboratory unit of study. If the lesson required the pre-preparation of sufficient items for subsequent student product evaluation exercises, this time was also recorded.

Compilation of market and equipment orders. Each lesson taught by the Control or Experimental I Methods of laboratory instruction required the compilation of market (food) and equipment orders to be used by the laboratory aides for purchase of the necessary food supplies and for laboratory set-ups. These market and equipment order requests must be completed at least one week prior to the date of the laboratory session. This task on the average required from 20 (Experimental I Method) to 60 minutes (Control Method) per lesson.

Instruction, grading and student counseling. The time required for instruction was tabulated as in-class instructional time for each laboratory method of instruction per unit of study. The time for grading was based on records of the time required to score, average and record grades for product summary outlines, product evaluations and laboratory unit tests. Student counseling time was estimated only for occasions where extra instructional effort was expended to clarify principles of product preparations or to explain typical product quality characteristics.

The summarized data for the time records and item estimates described are presented in Table 56.

Table 56

Total Instructional Staff Time Required Per Laboratory Method of Instruction for Laboratory Units of Study[a]

Laboratory Method of Instruction	Laboratory Unit of Study						Total Time Per Term (hours)
	A (hours)	B (hours)	C (hours)	D (hours)	E (hours)	F (hours)	
Control	4.67	19.17	24.50	10.50	15.50	11	85.34
Exp. I	4.67	16.50	16.83	13.50	23.50	11	86.00
Exp. II	4.67	11.17	13.17	5.83	8.17	11	54.01
Exp. III	4.67	2.50	2.50	2.50	2.50	11	25.67

[a]Calculations based on investigator's personal time records for duration of experiment.

The exercises and activities for Laboratory Units A and F were held constant as control factors for all laboratory sections and are included in Table 56 in order to estimate the total time per term for instruction by a single laboratory method of instruction. Only Laboratory Units B, C, D and E were taught by the Control, Experimental I, II or III Methods of laboratory instruction.

Laboratory Units B and C exhibit a decrease in the instructional staff time required as one proceeds down the column from the Control Method to Experimental I, II and III

Methods (Table 56). This occurs since progression down the column represents a decrease in the amount of instructor or student prepared products per method of laboratory instruction. This same tendency is noted for Laboratory Units D and E, with the exception of the figures for the Experimental I Method of instruction. Laboratory Units D and E each include a large variety of complicated food preparations which require extensive pre-preparation endeavors to such a degree that this method (Experimental I) as a sole means of instruction for these units of study is highly impractical.

Thus it can be seen that Experimental Methods II and III decrease the time required of instructional staff per laboratory unit of study by approximately one-half to three-fourths the time required by the Control Method. The time saved or perhaps the time increase due to the Experimental I Method depends entirely on the number of products to be prepared for that particular study unit. Experimental Method I, therefore, appears to be more appropriate to Laboratory Units B and C and, in all practicality, must be modified for use with Units D or E.

Non-Instructional Staff

Estimates of the amount of non-instructional staff time required to perform the pertinent activities for laboratory set-ups, clean-up and purchase of food supplies are

summarized in Table 57. The exercises and activities for Laboratory Units A and F were held constant as a control factor for all laboratory sections and are included in Table 57 in order to estimate the total non-instructional staff time required per term for each laboratory method of instruction tested. Only Laboratory Units B, C, D and E were taught by the Control, Experimental I, II or III Methods of instruction.

Table 57

Total Non-Instructional Staff Time Required Per Laboratory Method of Instruction for Laboratory Units of Study[a]

Laboratory Method of Instruction	Laboratory Unit of Study						Total Time Per Term (hours)
	A (hours)	B (hours)	C (hours)	D (hours)	E (hours)	F (hours)	
Control	2.00	13.33	15.00	7.30	12.50	8.33	58.46
Exp. I	2.00	9.00	11.00	5.00	6.50	8.33	41.83
Exp. II	2.00	4.00	5.00	2.00	4.33	8.33	25.66
Exp. III	2.00	0.00	0.00	0.00	0.00	8.33	10.33

[a]Calculations based on estimates for two laboratory aides.

The data for Laboratory Units B, C, D and E exhibit a decrease in the non-instructional staff time required as one proceeds down the column from the Control to Experimental I, II and III Methods. As was true for the instructional staff time data (Table 56), this occurs since progression down the column represents a decrease in the amount of instructor or student-prepared products per method of laboratory instruction except for the Experimental I Method of Units D and E. On the average, Experimental I, II and III Methods of laboratory instruction decrease the amount of non-instructional staff time required per unit of study by approximately 33 (Experimental I), 66 (Experimental II) or 100 percent (Experimental III).

Laboratory Operational Costs

Food Supplies

Market order records for each laboratory session were costed by the item amount used. Total costs for each laboratory unit of study tested (B, C, D and E) and per student costs per term were calculated for combined Winter and Spring Terms data as shown in Table 58. Laboratory Units A and F were constant for all laboratory sections and are included in Table 58 in order to calculate the total cost per term for instruction by a single method of instruction. Only Units B, C, D and E were taught by the Control, Experimental I, II and III Methods of laboratory instruction.

Table 58

Total Food Costs Per Laboratory Unit of Study for Four Methods of Instruction: Average of Winter and Spring Terms, 1975

Laboratory Method of Instruction	Laboratory Unit of Study						Total Cost Per Term Per Lab. Sec.	Cost Per Student Per Term
	A ($)	B ($)	C ($)	D ($)	E ($)	F ($)		
Control	1.21	23.50	46.25	40.02	43.17	8.91	163.06	8.15[a]
Exp. I	1.21	3.66	28.10	27.84	23.67	8.91	93.39	4.67
Exp. II	1.21	3.49	7.15	15.95	6.50	8.91	43.21	2.16
Exp. III	1.21	0.00	13.43	0.00	0.00	8.91	23.55	1.18

[a]Calculations based on average of 20 students per laboratory section.

Experimental Methods I, II and III decreased the calculated food costs per student per term by approximately 50, 75 or 90 percent, respectively, as compared to the Control Method of laboratory instruction. Each experimental method investigated, therefore, would produce a significant decrease in per student food costs for a course that has an average enrollment of 160 students per term.

Instructional and Non-Instructional Support Staff

Average Faculty, Graduate Teaching Assistant, Laboratory Aide and Work-Study Student salaries were estimated and the proportionate costs for operation of the laboratories calculated. The data in Table 59 present the estimated costs per term for instructional and non-instructional support staff for the Control Method of laboratory instruction.

Choosing Experimental Method I for instruction of the laboratory portion of HNF 100 would not decrease the total costs enumerated in Table 59 unless the student enrollment per laboratory section was increased in order to decrease the total number of laboratory sections taught and thus decrease the number of personnel required for actual laboratory instruction.

Table 59

Estimated Costs for Instructional and Non-Instructional Support Staff for the Control Method of Laboratory Instruction

Title	Per Term Cost ($)	Average Number Involved	Total Costs Per Term ($)
Faculty	4,250.00	1	4,250.00
Graduate Teaching Assistant	1,290.00	6	7,740.00
Laboratory Aide	1,650.00	2	3,300.00
Work-Study Student	270.00	1	270.00
Total			15,560.00

Adoption of the Experimental II or III Method of instruction could decrease the number of Graduate Teaching Assistants required for instruction and perhaps reduce the need for Laboratory Aides from two to one if laboratory sections were taught entirely by independent study. Thus, Experimental Methods II or III could potentially create the greatest decrease in costs for instructional and non-instructional support staff.

Test of Operational Null Hypothesis 4

H_o: The per student laboratory operational costs for expendable materials and instructional and non-instructional personnel for the laboratory portion of an elementary food preparation course taught by Experimental Methods I, II or III will not be less than comparable per student costs for the Control Method of laboratory instruction.

Data for total food costs, food costs per student per term, and instructional and non-instructional support staff indicate rejection of H_o. All three experimental methods (Experimental I, II and III) on the average cause a substantial decrease in per student costs per term for food supplies purchased for the laboratory units of study. Experimental Methods II and III would also decrease costs for instructional staff by requiring fewer Graduate Teaching Assistants for laboratory instruction.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this research project was the development of alternative instructional methods for the laboratory portion of an elementary food preparation course without qualitatively lessening student achievement.

Student pre-enrollment requests denied for HNF 100 average approximately 31.20 percent each term due to three interrelated factors: (a) course popularity vs. laboratory space limitations; (b) limitations with respect to qualified personnel to supervise and service the laboratory activities; and (c) the continuing rise in per student laboratory operational costs for food, supplies, equipment and instructional and non-instructional personnel. A solution to this problem was deemed critical by department and college administrative personnel.

To ascertain whether this situation was unique or shared by other institutions, a mail-questionnaire was designed to obtain information pertinent to current course offerings in elementary food preparation at 125 four-year, accredited universities and colleges in the Continental United States. This preliminary survey was conducted in

January 1974 to insure that any instructional techniques developed for use with HNF 100 would be applicable or capable of being adapted to similar teaching-learning situations involving instruction in basic skills and concepts of food preparation.

Preliminary Study Findings

Twenty of the 100 institutions which supplied usable data listed more than one elementary food preparation course; one designed for Foods and/or Home Economics Education Majors and a second structured for other majors. The majority of elementary food preparation courses reported were designed for classes composed of students with a variety of academic backgrounds and for instructional periods of 14 to 16 weeks. Eighty-one percent of the reporting institutions had five or fewer faculty in the area of Foods, and usually each person had assigned responsibility for more than one course per term in Foods or Food Science and Nutrition instructional programs.

The elementary food preparation courses at the institutions surveyed are taught each term of the academic year, have a common lecture section for all enrollees, and determine lecture enrollment by the number of laboratory spaces available. Each course has an average of three laboratory sections per term that are sometimes oversubscribed by one or two students per laboratory section.

Among the 125 courses listed, 17.6 percent had no males enrolled while 67.2 percent had less than six males per term. Two courses with more than 40 males per term enrolled were in institutions which have Hotel, Restaurant and Institutional Management Schools.

Instruction in elementary food preparation at the institutions was predominantly limited to one faculty member and, with the exception of six institutions, the teaching was done entirely by female faculty members. Eighty-two of the institutions had some student assistance for instruction with a predominance serviced by female graduate and undergraduate students. At 32 of the 100 institutions, the instructors had no assistance from student employees, maids or housekeepers.

The majority of students enrolled were in Foods and Nutrition programs or planned to teach Home Economics at the secondary level. Seventy of the 125 courses listed contained students from three or more different university classification levels.

Instructor demonstration of product preparation and discussion of product evaluations followed by student preparation and evaluation of selected products was the laboratory instructional method listed most often. Student self-study programs to supplement laboratory instruction were listed for five courses but no courses had the entire

laboratory instruction by student independent study. A variety of textbooks were used but laboratory manuals were most often instructor or staff-prepared.

These survey findings confirmed the fact that other institutions have the same difficulties relative to elementary food preparation laboratory instruction as those being experienced at Michigan State University.

Major Study Findings

The major portion of the study dealt with the formulation and testing of three experimental laboratory instructional methods for comparison to the current HNF 100 laboratory instructional method. The instructional methods developed were Experimental I, instructor demonstration and evaluation of instructor prepared products; Experimental II, a combination of Experimental I and independent study; and Experimental III, fifteen independent study modules for student self-instruction developed by the investigator. Each experimental method was equivalent to the Control (current instructional method) Method in subject matter content. The laboratory subject matter was divided into six units of study: (A) Laboratory Orientation; (B) Biscuits, Yeast Rolls, Fats and Oils, Cream Puffs, Pie Pastry and Butter Type Cakes; (C) Starches, Cereals, Milk and Cheese, Eggs, Custards and Egg Foam Products; (D) Meats,

Poultry and Fish; (E) Vegetables, Fruits, Salads, Mayonnaise Dressing and Gelatin Products; and (F) Final Examination. The Control Method was used for Units A and F for all four laboratory sections. The three experimental methods of instruction and the Control Method were applied to Units B, C, D and E by means of a Latin Square design. Four HNF 100 laboratory sections with a common lecture section were taught by the investigator both Winter and Spring Terms, 1975, with total term enrollments of 75 and 78, respectively.

Student background and experience were measured by collection of data on a personal information sheet and a written laboratory pre-test. Student learning and performance on laboratory exercises and activities were evaluated by achievement on product summary outlines, product evaluations, laboratory unit tests and a final laboratory examination. Student attitudes, another determinant of comparative effectiveness among the instructional methods tested, were assessed through compilation of student responses on four laboratory unit reactionnaires and a final laboratory evaluation form. Student, instructional and non-instructional laboratory time involvement and costs for food supplies per laboratory unit of instruction were also determined.

Since no attempt was made to select students on specific characteristics or to randomly assign them to groups, the first research task was characterization of the subjects in the sample. Students enrolled in each of the four laboratory sections each academic term were predominantly Sophomores and Juniors and the laboratory sections did not differ significantly in mean MSU Grade Point Averages. Fifty percent or more of the students in each laboratory section were Hotel, Restaurant and Institutional Management Majors with 62 to 83 percent of the total enrollment per laboratory section composed of Hotel, Restaurant and Institutional Management and Home Economics Education Majors who have HNF 100 as a requirement in their respective degree programs. Academic training in chemistry was most prevalent as high school general chemistry and previous food course and/or food preparation experiences were deemed negligible for all laboratory sections.

Comparison by Student's t of the mean number of correct responses per area of knowledge measured by a written pre-test demonstrated few significant differences among laboratory sections on basic measurement techniques, conversion calculations, techniques of standard methods of food preparation, food preparation temperatures and equipment identification and use. The eight laboratory sections of the study were shown comparable with little variability among the groups.

Student achievement on product summary outlines for laboratory sections taught by Experimental I, II or III Methods of laboratory instruction did not differ significantly from the achievement of comparable students taught by the Control Method for Laboratory Study Units B, C or E but there was a significant difference between the methods in Laboratory Unit D. Planned comparisons analysis demonstrated that the mean scores for the laboratory sections taught by the Control Method were significantly greater (higher achievement) than the mean scores for sections taught by Experimental Methods I, II and III.

Written product evaluations (discussions of quality characteristics) were required for the Control, Experimental I and Experimental II Methods of instruction for all four laboratory units of study. Analysis by Student's t of differences between mean scores for Winter and Spring Terms showed no significant differences attributable to instructional methods for Laboratory Unit B. For Laboratory Units C, D and E in both Winter and Spring Terms, the laboratory section taught by Experimental Method I had a significantly higher mean product evaluation score than the Control Method group. The Experimental II Method was superior to the Control Method for Laboratory Unit D only.

Laboratory Unit Tests I, II, III and IV had reliability coefficients (KR_{20}) of 0.6149 or better with little variability among the laboratory sections within or among the units of study. Content validity was substantiated by subjecting examinations to the review of three subject matter experts.

Student achievement on Laboratory Tests I, III and IV for the laboratory sections taught by Experimental I, II or III Methods of instruction did not differ significantly from the achievement of comparable students taught by the Control Method for Laboratory Study Units B, D and E. There was a significant difference attributable to method for Laboratory Test II. Planned comparisons analysis demonstrated that the Laboratory Test II, Unit C mean score for students taught by the Experimental Method III was significantly higher than the mean score for students taught by the Control Method. It appears that Experimental I, II or III Methods of laboratory instruction could be substituted for the Control Method and produce equivalent results in student achievement on Laboratory Unit Tests. Furthermore, Experimental Method III would probably effect greater student achievement than the Control Method of laboratory instruction on Laboratory Unit Tests.

Mean achievement scores on the final laboratory examination did not differ significantly among the four

laboratory sections taught by four different instructional sequences for Laboratory Study Units B, C, D or E in Winter or Spring Terms, 1975.

Student responses on the Laboratory Study Unit Reactionnaires showed a variety of differences in acceptability among the methods of laboratory instruction. All three experimental methods ranked higher than the Control Method on clarity of lesson objectives and directions with Experimental III Method consistently receiving the highest rank for all Units of Study (B, C, D, E). For topic organization and continuity, Experimental Method I consistently ranked higher than any other method (Control, Experimental II or III) for each unit of study. Experimental Methods II and III ranked lowest on rate of presentation due to the rapid rate of narration on the recorded tapes, with the Control Method ranking highest for Laboratory Units C and E and Experimental Method I ranking highest for Units B and D. Experimental Method I ranked highest for Laboratory Units B and D on terminology and example products used to illustrate principles while Experimental Method III received the highest rank for Laboratory Units C and E. The highest rank on overall quality of instructional method for all the laboratory units of study was received by Experimental Method I. For the last category, development of positive interest in the subject matter, the Control Method received the highest rank for all units of study (B, C, D, E).

Student reactions to the instructional methods tested repeatedly indicated that, in their view, the Control Method of laboratory instruction should be retained for all laboratory study units in HNF 100 and the independent study materials used for supplementary instruction and/or review purposes. Although students recognized and appreciated the value of the instructor demonstrations, they did not favor having instruction of entire laboratory sessions or units of study by this technique.

Student responses on the final laboratory evaluation indicated a Rank 1 (highest) position for the Control Method as the most effective for the presentation of the instructional materials in HNF 100. Experimental Methods I and III tied for Rank 2 while Experimental Method II received the lowest position of Rank 3. Students rated the Control Method as the most appropriate method of instruction for Laboratory Units B, D and E, with Experimental Method III rated best for Laboratory Unit C. The majority of the students were against laboratory instruction entirely by Experimental Methods I or III and stressed the value to students of actual hands-on-experiences (Control Method) in order to gain confidence and develop manipulative skills.

For Experimental Methods II or III single lessons (laboratory sessions) within Laboratory Units B, C, D or E, on the average, required from 40.12 to 68.46 minutes for

student completion of the independent study module. Lessons taught by either the Control or the Experimental I Methods required 110 minutes per lesson.

Experimental Methods II and III decreased the time required of the instructional staff per laboratory unit of study by approximately one-half to three-fourths the time required by the Control Method. On the average, Experimental Methods I, II and III decreased the amount of non-instructional time required per unit of study by 33, 66 and 100 percent, respectively.

As compared to the Control Method, Experimental Methods I, II and III decreased the food costs per student by approximately 50, 75 and 90 percent, respectively. Furthermore, if Experimental Method II or III should be used, decreases in instructional and non-instructional staff costs would parallel reductions in the number of graduate teaching assistants required and the kinds and amounts of non-instructional services needed.

Limitations of the Study

Of necessity, the time and cost figures for this study were, in part, based on estimates provided by the personnel responsible for the tasks performed. Interpretations of these data, therefore, are restricted but nonetheless vital to the determination of the overall merits of each instructional method tested.

Written product evaluations for lessons taught by Experimental Method III were not required but evaluation descriptions of products were provided for the student in the taped narration of the slide presentation and a product evaluation form in the student work sheet packet was completed by the student for study purposes. Incorporation of this requirement for a written product evaluation would facilitate the assessment of the effectiveness of learning achieved only through self-instruction.

The findings and conclusions of this research project are based on only one replication of the complex experimental design. Further testing of the experimental laboratory instructional methods with comparable student groups would enable the researcher to determine with greater accuracy the merits of each instructional method (Experimental and Control) for the designated laboratory units of study.

Development of the 15 independent study modules was a first experience in this technical area for the investigator. Consultation with experts in the field was sought and their advice was considered and implemented in many instances.

Implementation of the complex research design and the limited exposure of students to the variety of instructional methods used during the course of each term led to

some frustration and fatigue for the instructor and students. This concentrated and intense effort to arrive at accurate and reliable research findings involved no instructional assistance except for the grading of product summary outlines. In this instance, the investigator reviewed all product summary outlines graded by the graduate assistant for consistency and accuracy of grading among the laboratory sections. This high degree of investigator involvement was deemed necessary to maximize control and limit possible differences in instructional approaches that occur with more than one instructor.

Conclusions and Implications of the Study

Conclusions Per Laboratory Unit of Study

Laboratory Study Unit B. Based on the data analyses performed, student attitudinal data, and time and cost figures, this study unit (Biscuits, Yeast Rolls, Fats and Oils, Cream Puffs, Pie Pastry and Butter Type Cakes) might best be taught by a combination of the Control, Experimental I and III Methods of laboratory instruction. Since the Control and Experimental I Methods of instruction were shown to produce equivalent student achievement on product summary outlines, product evaluations and the laboratory unit test, a combination of instructor demonstration and discussion of

product evaluations followed by student preparation and evaluation of selected products appears justified. The Experimental III Method of instruction as suggested by the majority of students can be implemented by using the Laboratory Unit B independent study modules for student study guides prior to actual student preparation of products in the laboratory. These independent study modules should also be available for student use as review for examinations.

Laboratory Study Unit C. The consensus on instruction for this unit of study (Starches, Cereals, Milk and Cheese, Eggs, Custards and Egg Foam Products) appears to be a combination of the Control and Experimental III Methods of laboratory instruction. The Experimental I Method of instruction is not recommended due to the large amount of instructor pre-preparation time required for demonstrations. The Experimental II Method was ranked lowest by the students on all the attitudinal categories assessed and was characterized as confusing and difficult to follow. Thus, review of the independent study modules for this unit prior to actual student preparation laboratories provides the best combination of instructional techniques. Independent study modules should also be available for further student use as review for examination and study purposes.

Laboratory Study Unit D. The instructional method combination of greatest potential for this study unit (Meat, Poultry and Fish) is based on four factors: (a) the Control Method produced the highest student achievement on product summary outlines; (b) Experimental Method I was chosen best for product evaluation purposes; (c) Control, Experimental I II or III Methods produced equivalent results on the unit test; and (d) students preferred the Control Method but wanted Experimental Method III as a study guide and review. Thus, it is recommended that the independent study modules be used prior to actual student preparation laboratories that include short explanatory instructor demonstrations.

Laboratory Study Unit E. The data analyses for this unit of study (Vegetables, Fruits, Salads, Mayonnaise Dressing and Gelatin Products) indicate the use of a combination of the Control and Experimental III Methods of instruction. The Experimental I Method is not recommended due to the large amount of instructor pre-preparation time required for demonstrations. Experimental Method II was again rated low by students as compared to the other three methods and was described as confusing and difficult to follow. As seen for the other units of study, the best use of the independent study modules appears to be for study guides prior to the actual student preparation laboratories and as review for the unit examination.

Recommended Laboratory Instructional Sequence

The large verbal response of students in favor of the Control Method and its superiority for product summary outlines in Laboratory Unit D (Meat, Poultry and Fish) determine to a large extent the final decision on instructional methodology for HNF 100 laboratories.

Thus, the following format of instruction is recommended:

a. Continue to use the Control Method for Laboratory Units B, C, D and E with portions of Units B and D taught by the Experimental I Method (one laboratory session per week).

b. Incorporate the 15 independent study modules as study guides (directions) prior to the actual student preparation laboratories (one laboratory session per week). In addition, use the independent study modules as review for examinations.

When these suggestions are implemented, the following are predicted:

a. Total enrollment can be increased. At least 40 students per laboratory section could be enrolled since 20 of these students would be viewing an independent study module(s) while the remaining 20 students would prepare and evaluate products in the laboratory. For the following laboratory session the two groups would rotate.

b. One graduate teaching assistant (with only slight modifications in laboratory written assignments) will instruct twice as many students as with the current method of laboratory instruction without a significant increase in time required to execute his/her responsibilities. So realistically, this will evidence a decrease in instructional staff costs as compared to the current laboratory instructional plan.

c. The food costs per student per term will decrease due to the incorporation of Experimental Method I into Units B and D and the elimination of several duplicate student product preparations from all units of study.

d. Students with sufficient previous food preparation experiences can complete the laboratory portion of the course by independent study, thus reducing the per student costs per term.

e. Student achievement will be equivalent to that obtained by the current instructional method.

Based on the findings of this study and the investigator's own experiences with instruction of HNF 100 laboratories, these recommendations and predicted outcomes appear to be the most feasible for implementation into the current instructional plan.

Implications for Future Research

The experimental methods described and evaluated in this research project are highly versatile and offer extensive possibilities for instructional use in food preparation laboratories.

A possible next step in this investigation might implicate the use of the 15 independent study modules for completely self-paced laboratory instruction. Students, particularly those with considerable food preparation experience, might benefit greatly from the opportunity to "test-out" of laboratory subject matter areas where their expertise is above average and proceed to more

advanced topics. Open-laboratories for student preparation of products after completion of independent study modules would be desirable.

Student attitudinal responses in many instances indicated a desire on their part to participate in the instructor demonstrations. The effectiveness of student-instructor demonstrations should be investigated as a possible alternative instructional method, particularly for Laboratory Study Unit B.

Another aspect that deserves consideration is that instruction for this research study was the sole responsibility of one instructor who controlled the variability of presentation for the different laboratory groups. Thus, implementation of the four instructional methods by different instructors and/or graduate teaching assistants would provide useful information on the relative difficulty or ease of execution of these methods by different persons with variable amounts of skill and experience in the instruction of food preparation laboratories.

A last suggestion for future research is that of substantiating the effectiveness of the 15 independent study modules (after revision) by testing and evaluation with further classes or perhaps by investigators at another university or college.

Whatever the decision for the next step in investigation of this area of study, it is evident that the Experimental I and III instructional methods designed for the laboratory portion of HNF 100 did not qualitatively lessen student achievement as compared to the current instructional method. Each of the experimental methods (and the Control) deserves further study to determine which modification or application is most appropriate to food preparation laboratories.

APPENDICES

APPENDIX A

PRELIMINARY SURVEY

APPENDIX A

SURVEY QUESTIONNAIRE

MICHIGAN STATE UNIVERSITY East Lansing, Michigan 48824

Department of Food Science and Human Nutrition, College of Human Ecology

January, 1974

TO THE RESPONDENT:

The Food Science and Human Nutrition Department, College of Human Ecology, Michigan State University, is experiencing a student request for HNF 100, Elementary Food Preparation, that each term exceeds the available laboratory space and instructional personnel. As a Ph.D. candidate in this department, I am currently planning a study to develop a variety of laboratory instructional methods that will make it possible for us to: 1) enroll a greater number of students in the course, 2) control the costs of instruction within reasonable limits, and 3) facilitate the most efficient use of faculty time and effort without major alterations in the actual content, objectives or effectiveness of the course.

As an educator interested in instructional materials development, one of my first concerns is that any techniques proposed for use in our specific elementary food preparation course should also be applicable or capable of being adapted to similar situations involving instruction in basic skills and concepts of food preparation. The questionnaire presented here is designed to obtain information pertinent to current course offerings in elementary (introductory) food preparation at one hundred four-year, accredited universities and colleges in the Continental United States. It is hoped that data of this type will facilitate development of instructional materials relevant to a populace broader than just that at Michigan State University.

Your cooperation in the completion and return of this questionnaire by February 1 will be greatly appreciated. For your convenience, a self-addressed envelope is provided.

Sincerely,

Rose M. Tindall

Rose M. Tindall, M.S.
Teaching Assistant

* *

SURVEY OF COURSE OFFERINGS IN ELEMENTARY (INTRODUCTORY) FOOD PREPARATION

A. ORGANIZATION STRUCTURE: (complete as many as apply)

1. Name of University _____

   College _____

   School, Division, Department offering course(s) in food preparation

   _____

2. Instructional Term Basis: _____ quarter system _____ semester system

3. Teaching Faculty in Foods Area: total _____ (no.) full-time _____ (no.) part-time _____ (no.)

B. ELEMENTARY OR INTRODUCTORY FOOD PREPARATION COURSE(S) OFFERED:

Please list your elementary or introductory food preparation course(s) by course title in the space provided. For all succeeding survey items (1 through 16), record responses applicable to Course A in column A, Course B in column B, and Course C in column C.

COURSE TITLES:

A. _____

B. _____

C. _____

		COURSE A	COURSE B	COURSE C
1.	Lecture credit separate from lab.? (yes or no)			
2.	Course credit value(s): Lecture - Laboratory			
	Lecture (only)			
	Laboratory (only)			
3.	Number of times course is offered each year			
4.	Number of: a. lecture sections/term			
	b. class meetings/lecture section/wk			
	c. minutes/lecture session			
	d. students possible/lecture section/term (max. cap.)			
	e. students enrolled/lecture section/term (1972-73 AVG.)			
5.	Number of: a. lab. sections/term			
	b. class meetings/lab. section/wk			
	c. minutes/lab. session			
	d. students possible/lab. section/term (max. cap.)			
	e. students enrolled/lab. section/term (1972-73 AVG.)			
6.	Number of teaching faculty required each term: full-time			
	part-time			
7.	Number of: a. male teaching faculty			
	b. males enrolled in course each term (1972-73 AVG.)			
8.	Number of students assisting with instruction each term: graduate-male			
	graduate-female			
	undergraduate-male			
	undergraduate-female			

9. DUTIES ASSIGNED TO GRADUATE AND/OR UNDERGRADUATE STUDENTS ASSISTING WITH INSTRUCTION OF THE COURSE(S): (describe)

GRADUATE	UNDERGRADUATE
A.	A.
B.	B.
C.	C.

10. OTHER TECHNICAL ASSISTANCE REQUIRED FOR INSTRUCTION OF THE COURSE(S): (purchase of food supplies, lab. set-ups, cleaning, etc.)

A.

B.

C.

11. ACADEMIC PREREQUISITES FOR COURSE(S):

A	B	C

12. UNDERGRADUATE MAJORS REQUIRED TO TAKE THE COURSE(S):

A	B	C

13. UNDERGRADUATE MAJORS MOST FREQUENTLY TAKING THE COURSE(S) AS AN ELECTIVE:

A	B	C

14. THE COURSE ENROLLMENT USUALLY CONSISTS OF: (check one for each course)

A	B	C	
___	___	___	Freshmen only
___	___	___	Sophomores only
___	___	___	Freshmen and Sophomores
___	___	___	Sophomores and Juniors
___	___	___	Freshmen, Sophomores and Juniors
___	___	___	Sophomores, Juniors and Seniors
___	___	___	Juniors and Seniors
___	___	___	Freshmen, Sophomores, Juniors and Seniors

15. LABORATORY INSTRUCTION INVOLVES: (check all that apply for each course)

A	B	C	
___	___	___	Instructor demonstration of product preparation
___	___	___	Student demonstration of product preparation
___	___	___	Instructor-led discussion of product evaluation
___	___	___	Student-led discussion of product evaluation
___	___	___	Student preparation of selected products
___	___	___	Student evaluation of student-prepared products
___	___	___	Student evaluation of instructor/technician prepared products
___	___	___	Student independent study (no student-prepared products involved)

16. TEXTBOOKS AND/OR LABORATORY MANUALS USED: (Title and Author)

Course A. _____

_____

_____

Course B. _____

_____

_____

Course C. _____

_____

_____

* * * *

INSTITUTIONS REPORTING USABLE DATA

1. Nutrition and Foods
School of Home Economics
Auburn University
Auburn, Alabama 36104

2. Department of Home Economics
Jacksonville State University
Jacksonville, Alabama 36265

3. Dept. of Foods, Nutrition and Institution Management
School of Home Economics
Univ. of Alabama in Tuscaloosa
University, Alabama 35486

4. Department of Home Economics
Arizona State University
Tempe, Arizona 85281

5. Department of Home Economics
School of Applied Science
Northern Arizona University
Flagstaff, Arizona 86001

6. Food, Human Nutrition and Diet.
School of Home Economics
College of Agriculture
University of Arizona
Tucson, Arizona 85721

7. Foods and Nutrition
School of Agriculture
Calif. State Polytechnic Univ.
Pomona, California 91768

8. Division of Food and Consumer Science
College of Agriculture and Environmental Science
University of California, Davis
Davis, California 95616

9. Food Science and Nutrition
College of Home Economics
Colorado State University
Fort Collins, Colorado 80521

10. Department of Home Economics
University of Northern Colorado
Greeley, Colorado 80631

11. School of Home Economics
University of Connecticut
Storrs, Connecticut 06268

12. College of Home Economics
University of Delaware
Newark, Deleware 19711

13. Department of Food and Nutrition
School of Home Economics
Florida State University
Tallahassee, Florida 32306

14. Department of Home Economics
Idaho State University
Pocatello, Idaho 83201

15. Department of Home Economics
University of Idaho
Moscow, Idaho 83843

16. School of Home Economics
Eastern Illinois University
Charleston, Illinois 61920

17. Department of Home Economics
Illinois State University
Normal, Illinois 61761

18. School of Home Economics
Southern Illinois University
Carbondale, Illinois 62901

19. Department of Home Economics
Northern Illinois University
DeKalb, Illinois 60115

20. Department of Home Economics
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

21. Department of Home Economics
Ball State University
Muncie, Indiana 47306

22. Department of Home Economics
Indiana State University
Terre Haute, Indiana 47809

23. Dept. of Foods and Nutrition
School of Home Economics
Purdue University
West Lafayette, Indiana 47904

24. College of Home Economics
Iowa State University
Ames, Iowa 50010

25. Department of Home Economics
University of Iowa
Iowa City, Iowa 52240

26. Department of Home Economics
University of Northern Iowa
Cedar Falls, Iowa 50613

27. Department of Home Economics
Eastern Kentucky University
Richmond, Kentucky 40475

28. Department of Home Economics
Morehead State University
Morehead, Kentucky 40351

29. Department of Home Economics
Applied Sciences
Murray State University
Murray, Kentucky 42071

30. Dept. of Nutrition and
Food Science
College of Home Economics
University of Kentucky
Lexington, Kentucky 40506

31. Department of Home Economics
University of Louisville
Louisville, Kentucky 40208

32. School of Home Economics
Louisiana State University and
Agricultural and Mechanical
College
Baton Rouge, Louisiana 70803

33. College of Home Economics
Louisiana Tech. University
Ruston, Louisiana 71270

34. Department of Home Economics
Northeast Louisiana University
Monroe, Louisiana 71201

35. School of Home Economics
Univ. of Southwestern Louisiana
Lafayette, Louisiana 70501

36. School of Human Development
University of Maine in Orono
Orono, Maine 04473

37. Food, Nutrition & Institution
Administration
University of Maryland
College Park, Maryland 20742

38. Dept. of Nutrition and Food
University of Massachusetts
Amherst, Massachusetts 01002

39. Department of Home Economics
Central Michigan University
Mt. Pleasant, Michigan 48858

40. Department of Home Economics
Eastern Michigan University
Ypsilanti, Michigan 48197

41. Department of Home Economics
Northern Michigan University
Marquette, Michigan 49855

42. Department of Home Economics
Wayne State University
Detroit, Michigan 48202

43. Department of Home Economics
Western Michigan University
Kalamazoo, Michigan 49001

44. School of Home Economics
University of Minnesota
Minneapolis Minnesota 55455

45. Department of Home Economics
University of Minnesota-
Duluth
Duluth, Minnesota 55812

46. Department of Home Economics
Mississippi State University
Mississippi State, Mississippi
38762

47. Department of Home Economics
University of Mississippi
University, Mississippi 38677

48. Department of Home Economics
University of Southern
Mississippi
Hattiesburg, Mississippi 39401

49. Dept. of Food and Nutrition
School of Home Economics
University of Missouri
Columbia, Missouri 65201

50. School of Home Economics
Montana State University
Bozeman, Montana 59715

51. Department of Home Economics
University of Montana
Missoula, Montana 59801

52. Department of Home Economics
University of Nebraska-Omaha
Omaha, Nebraska 68101

53. School of Home Economics
University of Nevada
Reno, Nevada 89507

54. Home Economics
University of New Hampshire
Durham, New Hampshire 03824

55. Home Economics Department
Rutgers University
New Brunswick, New Jersey 08903

56. Department of Home Economics
Eastern New Mexico University
Portales, New Mexico 88130

57. Department of Home Economics
New Mexico State University
Las Cruces, New Mexico 88001

58. Department of Home Economics
University of New Mexico
Albuquerque, New Mexico 87106

59. Department of Home Economics
Brooklyn College
Brooklyn, New York 11210

60. Department of Home Economics
Appalachian State University
Boone, North Carolina 28607

61. School of Home Economics
East Carolina University
Greenville, North Carolina 27834

62. Department of Home Economics
North Carolina Agricultural &
Technichological State Univ.
Greensboro, North Carolina 27411

63. School of Home Economics
University of North Carolina
at Greensboro
Greensboro, North Carolina 27412

64. Dept. of Food and Nutrition
College of Home Economics
North Dakota State University
Fargo, North Dakota

65. Department of Home Economics
Bowling Green State University
Bowling Green, Ohio 43403

66. School of Home Economics
Kent State University
Kent, Ohio 44242

67. Department of Home Economics
Miami University
Oxford, Ohio 45056

68. School of Home Economics
Ohio State University
Columbus, Ohio 43210

69. Department of Home Economics
Ohio University
Athens, Ohio 45701

70. Department of Home Economics
University of Akron
Akron, Ohio 44325

71. College of Education and
Home Economics
University of Cincinnati
Cincinnati, Ohio 45221

72. Department of Home Economics
Youngstown State University
Youngstown, Ohio 44503

73. Department of Food, Nutrition
and Institutional Management
College of Home Economics
Oklahoma State University
Stillwater, Oklahoma 74074

74. School of Home Economics
University of Oklahoma
Norman, Oklahoma 73069

75. Foods and Nutrition
School of Home Economics
Oregon State University
Corvallis, Oregon 97331

76. Department of Home Economics
Indiana University of Penna.
Indiana, Pennsylvania 15701

77. Nutrition Department
College of Human Development
Pennsylvania State University
University Park, Pennsylvania
16802

78. Food and Nutrition Science
College of Home Economics
University of Rhode Island
Kingston, Rhode Island 02881

79. Nutrition and Food Science
College of Home Economics
South Dakota State University
Brookings, South Dakota 57006

80. Department of Home Economics
East Tennessee State
Johnson City, Tennessee 37601

81. Department of Home Economics
Memphis State University
Memphis, Tennessee 38111

82. Department of Home Economics
Middle Tennessee State Univ.
Murfreesboro, Tennessee 37130

83. School of Home Economics
Tennessee Tech. University
Cookeville, Tennessee 38501

84. Food Science and Institution
Administration
College of Home Economics
University of Tennessee
Knoxville, Tennessee 37916

85. School of Home Economics
University of Tennessee
Martin, Tennessee 38327

86. Department of Home Economics
Texas Arts and Industries
University
Kingsville, Texas 78363

87. Department of Home Economics
Texas Southern University
Houston, Texas 77004

88. Department of Home Economics
Texas Woman's University
Denton, Texas 76204

89. Department of Home Economics
University of Texas at Austin
Austin, Texas 78712

90. Department of Home Economics
University of Utah
Salt Lake City, Utah 84112

91. Department of Home Economics
and Consumer Education
Utah State University
Logan, Utah 84321

92. Home Economics Department
University of Vermont
Burlington, Vermont 05401

93. Department of Home Economics
Norfolk State University
Norfolk, Virginia 23504

94. Human Nutrition and Foods
College of Home Economics
Virginia Polytech. Institute
and State University
Blacksburg, Virginia 24061

95. School of Home Economics
University of Washington
Seattle, Washington 98105

96. Dept. of Foods and Nutrition
and Institutional Management
College of Home Economics
Washington State University
Pullman, Washington 99163

97. Division of Family Resources
West Virginia University
Morgantown, West Virginia 26506

98. School of Family Resources
and Consumer Sciences
University of Wisconsin
Madison, Wisconsin 53706

99. School of Home Economics
Univ. of Wisconsin at Milwaukee
Milwaukee, Wisconsin 53201

100. Division of Home Economics
College of Agriculture
University of Wyoming
Laramie, Wyoming 82070

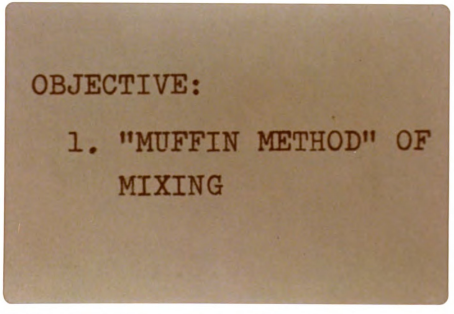
APPENDIX B

INDEPENDENT STUDY MODULE

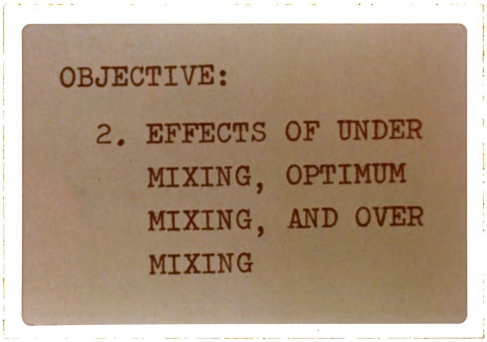
(Topic: Muffins)

PHOTOGRAPHS OF STUDY MODULE SLIDES

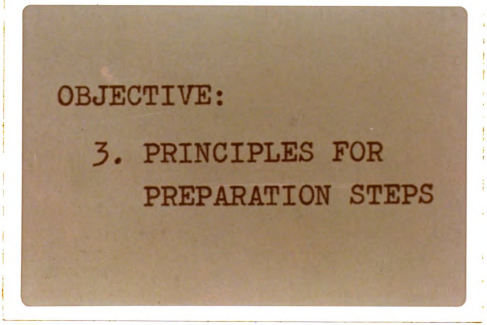
1. Title slide.



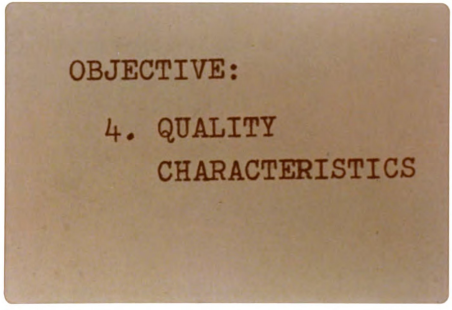
2. Objective one.



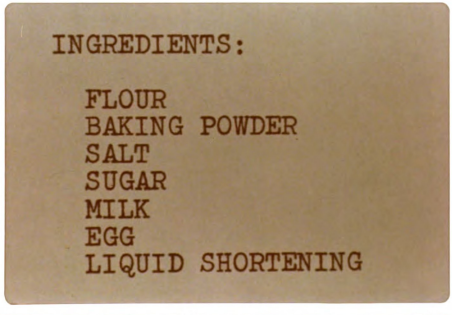
3. Objective two.



4. Objective three.



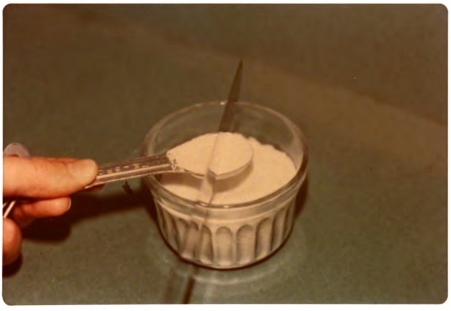
5. Objective four.



6. Ingredient functions.

7. Preparation of baking pan.

8. Measurement of flour.



9. Measurement of sugar, baking powder or salt.

10. Dry ingredients placed in sifter.

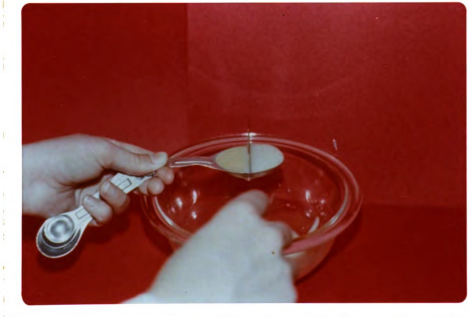
11. Sifting dry ingredients together.

12. Formation of well in dry ingredients.

13. Examination of egg clarity.

14. Blending of egg yolk and albumen.

15. Illustration of correctly blended egg.



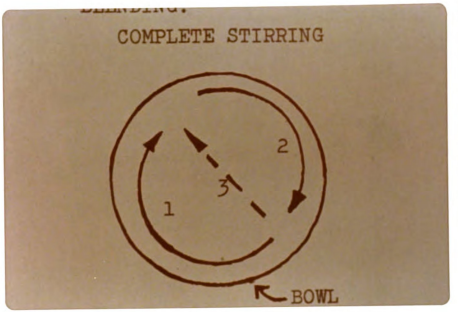
16. Measurement of blended egg.

17. Measurement of milk.

18. Combination of oil, milk and egg.

19. Temporary emulsion formation.

20. Addition of liquid to dry ingredients.



21. Initial mixing step.

22. Undermixed muffin batter.

23. Filling muffin cup.

24. Optimum mixed muffin batter.

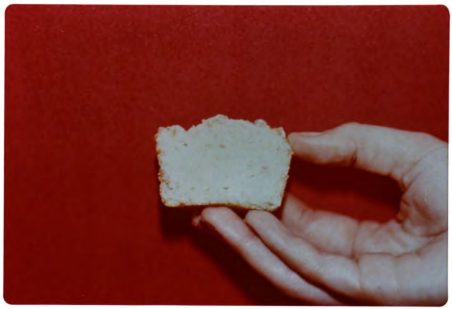
25. Filling muffin cup.

26. Overmixed muffin batter.

27. Comparison of undermixed, optimum and overmixed muffin batters.

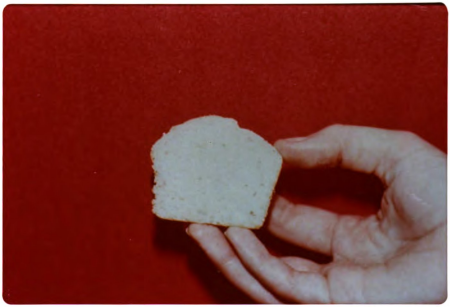
28. Muffins after baking.

29. Undermixed muffin (exterior).



30. Undermixed muffin (interior).

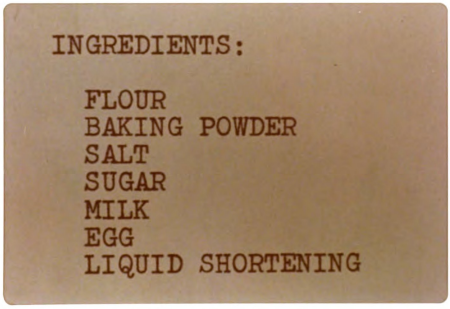
31. Optimum mixed muffin (exterior).



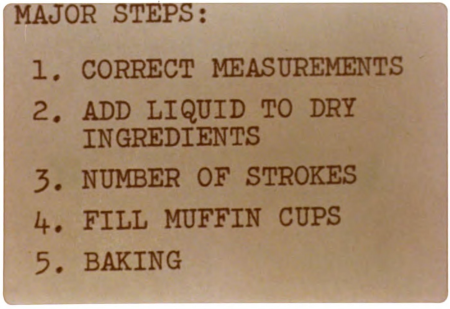
32. Optimum mixed muffin (interior).

33. Overmixed muffin (exterior).

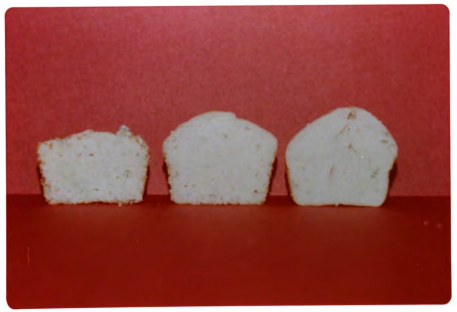
34. Overmixed muffin (interior).



35. Major ingredient functions (review).



36. Major preparation steps (review).



37. Comparison of undermixed, optimum and overmixed muffin quality characteristics.

AUDIO-SCRIPT: "MUFFINS"

LABORATORY II

1 (1) Welcome to the lesson entitled "The Muffin Method of Mixing." Turn on the slide projector and advance to the title slide. Before we begin consideration of the specific preparation steps I'd like to discuss your work sheet and those points of information to be obtained from this lesson. Page 1, item I is a list of muffin ingredients. As these are discussed in the presentation, please take note of their major functions. Page 2, item II, details the major preparation steps. All steps will be explained on the basis of principles involved or reasons for specific manipulations performed in the preparation of the finished product. You may need to stop the tape and go back over some points in order to write down all the information needed. This is an essential part of the presentation and should be completed before proceeding further. Page 3, item III is space for personal notes that may aid you in study or help you remember the information discussed in the slide-tape presentation. Page 4, item IV is a product evaluation sheet to be filled out for each type of muffin as the quality characteristics are discussed. Page 4, item V is a summary list of key terms that you should be able to define or explain after completing your study of this lesson.

Proceed to the next slide throughout this presentation at the sound of the tone.

TONE

2 (2a) There are four basic objectives for consideration in this lesson. Number one involves recognizing and understanding the steps in the "Muffin Method" of mixing.

TONE

3 (2b) The second objective indicates that you analyze the procedures for undermixing, optimum mixing and overmixing and be able to predict the possible effects on product quality.

TONE

4 (2c) Objective three indicates that you observe and study the basic steps of preparation and apply the principles or reasons for these techniques to each step.

TONE
5 (2d) Objective four involves writing descriptions of products that result from undermixing, optimum mixing and overmixing. This is accomplished by comparing recognized characteristics of a high quality muffin to those products obtained by the mixing procedures used here.

TONE
6 (3) Recipe ingredients function in varied ways that ultimately determine the quality characteristics of the specific product.

FLOUR provides the basic framework for muffin structure through the formation of gluten strands. Starch granules contribute to texture and structure.

BAKING POWDER is a leavening agent and produces carbon dioxide to obtain maximum product volume.

SALT contributes flavor.

SUGAR contributes flavor, tenderizes through peptization of protein and aids in browning.

MILK provides the water to activate the leavening agent and hydrate the dry ingredients.

EGG contributes to flavor, provides an emulsifier to aid an oil in liquid emulsion, and may enhance color.

LIQUID SHORTENING may increase tenderness by shortening gluten strands.

Proceed to Page 2 of the work sheet so you may record the principles of preparation for the mixing steps as they are presented. Page 3 provides space for additional notes.

TONE
7 (4) The first step in the preparation of most baked products is to prepare the pan or utensil in which the food item will be cooked. For preparation of the muffin pan the finger tips are wrapped in waxed paper then dipped in liquid shortening before greasing the bottom but not the sides of the individual muffin cups. This prevents the muffins from sticking to the pan and makes removal from the pan easier. The sides of the muffin tin are not greased since greasing would interfere with obtaining maximum volume by not allowing the batter to adhere to the sides and climb above the surface of the container.

TONE
8 (5a) The next step is accurate measurement of dry ingredients. Flour is measured by:

1. sifting
2. lightly spoon into a metal measuring cup and heap above the top edges
3. level with a straight edge metal spatula.

Sifting before measuring prevents the flour from packing and incorporating too much flour into the recipe. Sifting also facilitates mixing.

TONE
9 (5b) Sugar, baking powder and salt are measured in the same manner. Check the sugar and baking powder to insure that there are no lumps. Use the appropriate metal measuring cup or calibrated measuring spoon and heap the dry ingredients above the surface of the container, then level with a straight edge metal spatula. Inaccuracy in measurement changes ingredient proportions in the recipe and alters the quality of the finished product.

TONE
10 (5c) Place the dry ingredients into a sifter.

TONE
11 (5d) Sift these dry ingredients together into a 2-quart mixing bowl. Use a spoon to aid in sifting. This technique facilitates even distribution of all dry ingredients especially the baking powder for quicker mixing and uniform leavening.

TONE
12 (6) With a spoon make a well in the center of the dry ingredients. This will enable easier blending with the liquid ingredients with fewer strokes.

TONE
13 (7) Break the egg into a dish to check its quality before adding to the other ingredients. Eggs that are deteriorated or have large blood spots are not suitable for use.

TONE
14 (8a) Beat the egg with a hand beater, mixer or fork.

TONE
15 (8b) The beaten egg should have all the albumen and yolk well blended but not foamy.

TONE
16 (8c) Measure the desired amount of beaten egg in a calibrated measuring spoon and remove any foam from the surface with a straight edge metal spatula. Make sure the beaten egg completely fills the measuring spoon. Place the measured egg in a one-quart mixing bowl.

TONE
17 (9) Milk is measured at eye level in a glass measuring cup using the bottom of the meniscus as the desired measure line. The liquid shortening is measured using the calibrated measuring spoons since only 2 T. are needed. Quantities beginning with ¼ cup and larger are measured in the liquid or glass measuring cup.

TONE
18 (9a) Combine the oil, milk and egg and blend with a hand beater or mixer.

TONE
19 (9b) Mechanical mixing breaks up fat globules and disperses them throughout the egg-milk mixture to facilitate uniform and more rapid blending with the dry ingredients. This mixture is a temporary emulsion since the fat will separate on standing.

TONE
20 (10) Add all the liquid mixture at one time to the dry ingredients pouring directly into the well. If dry ingredients were added to the liquid mixture the blending or mixing time would take far too long and be much more difficult.

TONE
21 (11) Stir in a circular pattern with occasional strokes through the center of the batter as indicated by the third arrow.

Stir 5-6 strokes, occasionally scraping the sides of the bowl to facilitate thorough mixing.

TONE
22 (12) Some of the dry ingredients will not be incorporated at this point. The undermixed batter appears as you see it in this slide.

TONE
23 (13) Enough batter is removed to fill the muffin cup two-thirds full. The spoon should be held close to the muffin cup and the batter pushed with a rubber spatula from the spoon into the cup. Batter dropped from a greater height into the muffin tin loses leavening gas, stretches gluten strands and may drop onto the surface between the cups which presents a clean-up problem.

TONE
24 (14) Continue to mix 5-10 more strokes or until all dry ingredients are moistened. The batter appears lumpy but evenly mixed. This batter should produce an optimum muffin due to the appropriate amount of dry ingredient hydration and gluten development.

TONE
25 (15) Three muffin cups are filled two-thirds full using the same techniques as for the undermixed muffin since the same principles apply here.

TONE
26 (16) Now the batter is beaten at least 50 more strokes for the overmixed muffins. These vigorous strokes produce a very smooth batter that sheets from the spoon due to highly developed strands of gluten.

TONE
27 (17) For comparison this slide shows all batters in the muffin tin. The undermixed batter has apparent flour on the surface. The optimum mix is lumpy but all dry ingredients are moistened. The overmixed batter is smooth and doesn't appear as thick or bubbly as the standard.

The muffin pan is placed in an oven preheated to 425° F. The pan should be centered in the oven so that heat is distributed evenly around all sides of the pan to prevent uneven baking and browning.

During the baking process some important changes occur. The high temperature is necessary for rapid expansion and production of carbon dioxide.

Proteins (mainly gluten and egg protein) coagulate while starch gelatinizes, both of which contribute to muffin structure and texture. Browning results from a combination of three reaction mechanisms. These are caramelization of sugar, dextrinization of starch and a protein-carbohydrate interaction called the Maillard Reaction. Maillard is spelled M a i l l a r d.

TONE
28 (19a) When the muffins are observed after baking, it is quite obvious that each variation in mixing produces a distinctly different product.

The underblended muffin is in the lower left and shows little if any increase in volume upon baking.

The optimum muffins are located in the upper left and two center cups, while the overmixed occupy the upper and lower right positions.

Please note the difference in browning, particularly that the overmixed muffins are pale though larger than the optimum muffin.

TONE
29 (20a) Turn now to page 4, item IV of your work sheet for the discussion of quality characteristics. Remember that the column headed optimum is the ideal quality product.

First, the underblended muffin:

- Volume is small, little increase from unbaked state.
- Browning is uneven with areas of unmixed flour on the surface.
- The surface is irregular and rough.

TONE
30 (20b) The texture is coarse with rather compact cells. There may also be areas of unmixed ingredients that resulted in unbaked or soggy clumps.

The product usually has soggy areas as well as dry coarse regions both of which indicate uneven blending.

The undermixed muffin offers resistance to breaking apart as well as biting and chewing.

When eaten, the undermixed muffin may taste of baking powder, flour or other unevenly distributed ingredients.

TONE
31 (21a) The optimum muffin exhibits good volume, meaning that it increased to maximum without forming peaks.

All surfaces are a light golden brown.

The crust has a pebbled or cauliflower-like appearance and a rounded surface.

TONE
32 (21b) Cell structure is uniform with only a few medium to large gas pockets.

The product is slightly moist and offers little resistance to breaking, biting or chewing.

The flavor should be bland, but some individuals may detect a slight sweetness. The term bland does not mean blah. Plain muffins should compliment a meal not dominate its flavor. They are most often accented with butter, jams, jellies and preserves.

TONE
33 (22a) The overmixed muffin has the largest volume with a peaked, often times, split surface.

The browning is irregular and some areas may be light with almost no browning while other regions (especially cracks) are burned.

Note the very smooth surface. This is typical of the highly developed gluten in this muffin.

TONE
34 (22b) The interior of this product has a predominant pattern of tunnels running from bottom to top. Very elastic gluten strands controlled gas flow in this manner.

The crumb is slightly dry and offers much resistance to biting and chewing. Or in other words, the muffin is tough.

The flavor is bland but the rubbery texture is so undesirable that one may be tempted to describe the flavor as chewy or rubbery.

This completes the information on muffins but in order to check and review your notes turn back to page 1, item I of your work sheet and I'll outline the major points.

TONE
35 (23a) The major ingredient functions are as follows:

FLOUR--structure, gluten development.

BAKING POWDER--leavening agent, carbon dioxide production.

SALT--flavor.

SUGAR--tenderization, peptization.

MILK--water to activate the leavening agent and hydrate the dry ingredients.

EGG--affects color and flavor and supplies emulsifier.

LIQUID SHORTENING--tenderizes, shortens gluten strands.

TONE

36 (23b) Next a brief review of the major preparation steps:

1. Correct measurements	1. It is necessary for ingredients to be in accurate proportions to each other to produce a high quality muffin.
2. Add liquid to dry ingredients	2. Facilitates mixing with the least number of strokes to control gluten development.
3. Number of strokes	3. This determines the elasticity of gluten strands and tenderness of the muffin.
4. Fill muffin cups	4. Hold the spoon close to the muffin cup to prevent loss of leavening gas and further stretching of gluten strands.
5. Baking	5. 425° F until golden brown Reactions: • Coagulation of protein, • Gelatinization of starch, • Browning.

TONE

37 (23c) This slide from left to right presents a comparison of underblended, optimum and overmixed muffins. Compare their characteristics by studying page 3, item IV of your work sheet.

Review any part of the slide-tape presentation that you deem necessary to make your notes more complete.

When you are finished, turn the on-off switch on the slide projector to FAN and allow at least a five-minute cool down period before switching off the projector.

Next, rewind the tape and return it with the slides to the storage area where they were first obtained.

STUDENT DIRECTIONS AND WORK SHEET

"MUFFINS"

DIRECTIONS:

1. Review the entire "Student Work Sheet" to identify the pertinent information to be secured from the slide-tape presentation.

2. Read directions for audio-visual equipment operation.

3. Study the slide-tape presentation and complete all blank items on the "Student Work Sheet." Retain this work sheet for future reference and as a study guide for laboratory quizes.

4. Approximate time to complete Lesson II (Muffins) = 110 minutes or less.

5. Direct any questions to your HNF 100 instructor as soon as possible after completing the assignment.

STUDENT WORK SHEET

LABORATORY II

"MUFFINS"

OBJECTIVES: EXPECTED LEARNING OUTCOMES

1. Recognize and understand the steps in the "Muffin Method" of mixing.

2. Analyze the procedures for undermixing, optimum mixing and overmixing and predict the possible effects on product quality.

3. Understand the basic steps in preparation and identify in writing the principles involved.

4. Apply the general quality characteristics of muffins to the products that result from undermixing, optimum mixing and overmixing.

I. INGREDIENT FUNCTIONS:

A. FLOUR--

B. BAKING POWDER--

C. SALT--

D. SUGAR--

E. MILK--

F. EGG--

G. LIQUID SHORTENING--

II. MAJOR PREPARATION STEPS: (Standard Muffin Only)	PRINCIPLES
1. Correct measurements.	1.
2. Sift dry ingredients together and make well in center	2.
3. Mix oil, egg and milk	3.
4. Add liquid to dry ingredients	4.
5. Stir until dry ingredients are moistened	5.
6. Push batter from spoon into muffin tin with spoon close to cup	6.
7. Center pan in oven	7.
8. Bake at 425° F	8.

III. **SUPPLEMENTARY NOTES:**

IV. QUALITY CHARACTERISTICS:

		Undermixed	Optimum	Overmixed
EXTERIOR	Volume			
	Color			
	Shape			
	Other Comments:			
INTERIOR	Texture			
	Moistness			
	Tenderness			
	TASTE or FLAVOR			

V. KEY TERMS:

Muffin Method
Gluten strands
Standard or Optimum product
Cell size
Cell walls
Grain
Emulsion
Leavening
Browning--Caramelization, Dextrinization, Maillard Reaction
Albumen (egg white)
Meniscus
Coagulation
Gelatinization

APPENDIX C

INSTRUMENTATION

APPENDIX C

PERSONAL INFORMATION SHEET

1. NAME: _____
   (Last) (First) (Middle)

2. COLLEGE: _____ Student Number: _____

   MAJOR: _____

3. FRESHMAN:_____ SOPHOMORE:_____ JUNIOR:_____ SENIOR:_____ OTHER:_____

4. GRADE POINT AVERAGE: MSU:_____ TRANSFER:_____

5. HNF 100: _____ Elective _____ Required

6. Have you been refused enrollment in HNF 100 previously? (Yes or No. Explain why, if you know the reason.)

7. ACADEMIC TRAINING:
   a. Chemistry Courses: _____
      (Specify subject matter areas; or indicate if high school course.)

   b. College of Human Ecology Courses: _____

      _____
      (Specify by dept. and number only foods or food-related courses.)

   c. Hotel, Restaurant, Inst. Courses: _____

      _____
      (Specify by dept. and number only foods or food-related courses.)

8. WORKING EXPERIENCE: (Only those with food preparation involvement. May indicate home preparation experiences.)

HNF 100
PRE-TEST

Name _____
Laboratory Section _____

1. Choose the most appropriate answer that describes the accurate measurement of the following basic ingredients. If you do not know how to measure the ingredient, and your answer would only be a guess, mark NO OPINION.

   A. MILK: 1 cup

      1. Pour the milk into a metal measuring cup until the liquid is even with the rim.

      2. Pour the milk into a glass (liquid) measuring cup until the bottom of the meniscus at eye level rests at the one cup graduated mark.

      3. Either 1 or 2.

      4. NO OPINION.

   B. FLOUR: 1/2 cup

      1. Sift the flour, spoon into a ½ cup metal measuring cup, level with a straight edge metal spatula.

      2. Sift the flour, spoon into a ½ cup metal measuring cup, pack down, level with a straight edge metal spatula.

      3. Either 1 or 2.

      4. NO OPINION.

   C. SUGAR, granulated: 2 Tablespoons

      1. Sift, fill 1 Tablespoon calibrated measuring spoon; repeat.

      2. Fill 1 Tablespoon calibrated measuring spoon, level with a straight edge metal spatula; repeat.

      3. Either 1 or 2.

      4. NO OPINION.

D. BROWN SUGAR (not Brownulated): 1/4 cup

1. Pack the brown sugar into a ¼ cup metal measuring cup, level with a straight edge metal spatula.

2. Pack the brown sugar into a ¼ cup glass (liquid) measuring cup, level with a straight edge metal spatula.

3. Either 1 or 2.

4. NO OPINION.

E. BAKING POWDER: 4 teaspoons

1. Stir to break up any lumps, fill 1 teaspoon calibrated measuring spoon, level with a straight edge metal spatula; repeat for a total of 4 teaspoons.

2. Stir to break up lumps, fill 1 Tablespoon and 1 teaspoon calibrated measuring spoons, level with a straight edge metal spatula.

3. Either 1 or 2.

4. NO OPINION.

F. SALAD OIL: 1 Tablespoon

1. Pour oil into a 1 Tablespoon calibrated measuring spoon.

2. Pour oil to 1 Tablespoon mark on a glass (liquid) measuring cup. Measure meniscus at eye level.

3. Either 1 or 2.

4. NO OPINION.

G. EGG: 2 Tablespoons

1. Beat egg until evenly blended. Fill a 1 Tablespoon calibrated measuring spoon, remove foam. Repeat once.

2. Beat egg until evenly blended. Pour into a liquid measuring cup up to the 2 Tablespoon mark.

3. Either 1 or 2.

4. NO OPINION.

H. SOLID FAT: 1/4 cup

1. Pack a ¼ cup metal measuring cup with fat, level with a straight edge metal spatula.

2. Add fat to 3/4 cup of water in a glass (liquid) measuring cup, press the fat to the bottom of the cup until the water level reaches 1 cup.

3. Either 1 or 2.

4. NO OPINION.

2. Complete the following conversions or calculations:

A. ½ of ¼ teaspoon = _____ teaspoon.

B. 3 teaspoons = _____ Tablespoon.

C. ½ cup = _____ Tablespoons = _____ teaspoons.

D. ¼ pound = _____ grams.

E. 1 cup = _____ ounces.

F. 1 pint = _____ cups.

3. True or False

1. _____ Rinse starchy products from dishes with cold water.

2. _____ Stir muffin batter until it is smooth and free of lumps.

3. _____ Open the oven door occasionally throughout the baking period to check on cakes or cream puffs.

4. _____ Place biscuits on a rack near the top of the oven for more complete browning.

5. _____ Rolling pastry dough between sheets of waxed paper prevents sticking to the rolling pin and tearing gluten strands.

6. _____ Roll pie pastry to ¼ inch thickness.

7. _____ Folding is a process used for blending beaten egg white with other ingredients.

8. _____ Score fat edges on meats to prevent curling while pan frying.

9. _____ Grease the bottom and sides of a cake pan to obtain maximum volume.

10. _____ While making a cake, scrape the sides of the bowl occasionally to insure thorough blending.

11. _____ Egg whites whip more readily at room temperatures.

12. _____ Stir cornstarch into a hot liquid to get a smooth mix.

13. _____ Pour off fat drippings as they collect in pan frying.

14. _____ Cook vegetables in a minimum of water at boiling temp.

15. _____ Gelatin molds should be congealed in the freezer.

4. Match the appropriate temperature range for baking to these products.

1. 400-450° F 2. 350-375° F 3. 275-325° F

A. _____ Biscuits F. _____ Muffins

B. _____ Yeast Rolls G. _____ Cream Puffs

C. _____ Custards H. _____ Angel Cake

D. _____ Souffles I. _____ Pork Roast

E. _____ Layer Cake J. _____ Beef Roast

5. Equipment Identification (on demonstration table):

1. _____ 9. _____

2. _____ 10. _____

3. _____ 11. _____

4. _____ 12. _____

5. _____ 13. _____

6. _____ 14. _____

7. _____ 15. _____

8. _____ 16. _____

STUDENT REACTIONNAIRE

METHOD: CONTROL
EXPERIMENTAL I

LAB SECTION: _____

Please be frank and honest in answering the following questions.

KEY: SA means you strongly agree; A means you agree; U means you are uncertain; D means you disagree; and SD means you strongly disagree.

1.	I was often unsure of what, exactly, I was supposed to be learning.	SA	A	U	D	SD
2.	The lessons were well organized. The concepts were highly related to each other.	SA	A	U	D	SD
3.	There was too much information presented in the lessons.	SA	A	U	D	SD
4.	There was not enough repetition of the important concepts.	SA	A	U	D	SD
5.	Parts of the lessons were unclear. I had to ask many questions.	SA	A	U	D	SD
6.	The worksheets were well designed. I could easily follow the instructions and perform the exercises.	SA	A	U	D	SD
7.	The example products effectively illustrated the principles being discussed.	SA	A	U	D	SD
8.	The vocabulary used in the discussions contained many unfamiliar words. I often did not understand what was going on.	SA	A	U	D	SD
9.	The rate of presentation for the lessons was too fast.	SA	A	U	D	SD
10.	Many of the things I was asked to do or questions I was asked to answer during the lessons seemed like needless busy work.	SA	A	U	D	SD
11.	At the end of the lessons I was still uncertain about a lot of things, especially what I was expected to know.	SA	A	U	D	SD

12. I would recommend extensive modifications to the lessons before using them with other students. SA A U D SD

13. After completing the lessons, I was more interested in and/or favorably impressed with the general subject matter than I was before the lessons. SA A U D SD

14. The objectives of the lessons were clearly stated and easily understood. SA A U D SD

15. Please summarize in one sentence your overall reaction to the unit of study.

16. In one sentence, state what you believe to be the best or most interesting feature of the unit of study just completed.

17. Were any lessons in this unit of study not suitable to the method or presentation used? If so, which one(s)? Why?

18. Write below any suggestions that you believe will improve the unit of study.

STUDENT REACTIONNAIRE

METHOD: EXPERIMENTAL II
EXPERIMENTAL III

LAB SECTION: _____

Please be frank and honest in answering the following questions.

KEY: SA means you strongly agree; A means you agree; U means you are uncertain; D means you disagree; and SD means you strongly disagree.

1.	I was often unsure of what, exactly, I was supposed to be learning.	SA	A	U	D	SD
2.	Listening to the tapes and watching the slides was often boring.	SA	A	U	D	SD
3.	The lessons were very well organized. The concepts were highly related to each other.	SA	A	U	D	SD
4.	There was too much information in the lessons.	SA	A	U	D	SD
5.	There was not enough repetition of the important concepts.	SA	A	U	D	SD
6.	Parts of the lessons were unclear. I often needed to relisten to the tape.	SA	A	U	D	SD
7.	The worksheets were well designed. I could easily follow the instructions and perform the exercises.	SA	A	U	D	SD
8.	Often the tape and slides seemed unrelated to each other.	SA	A	U	D	SD
9.	The example products effectively illustrated the principles being discussed.	SA	A	U	D	SD
10.	The vocabulary used in the demonstrations and/or taped discussions contained many unfamiliar words. I often did not understand what was going on.	SA	A	U	D	SD
11.	The rate of presentation on the tapes was too fast.	SA	A	U	D	SD

12. Many of the things I was asked to do, or questions I was asked to answer during the lessons seemed like needless busy work. SA A U D SD

13. At the end of the lessons I was still uncertain about many concepts and had to do a lot of studying on my own (outside of class). SA A U D SD

14. I believe I learned a lot from the slide-tape presentation. SA A U D SD

15. I would recommend extensive modifications to the lessons before using them with other students. SA A U D SD

16. After completing the lessons, I was more interested in and/or favorably impressed with the general subject matter than I was before the lesson. SA A U D SD

17. The objectives of the lessons were clearly stated and easily understood. SA A U D SD

18. I had a hard time operating the AV equipment SA A U D SD

19. Please summarize in one sentence your overall reaction to this unit of study.

20. In one sentence, state what you believe to be the best or most interesting feature of this unit of study.

21. Were any lessons in this unit of study not suitable to the method of presentation used? If so, which one(s)? Why?

22. Write below any suggestions or changes that you believe will improve the unit of study.

STUDENT REACTIONNAIRE

FINAL LABORATORY EVALUATION

LAB SECTION: _____

TERM: _____

PLEASE BE FRANK AND HONEST IN ANSWERING THE FOLLOWING QUESTIONS.

1. Rank the following methods of instruction from 1 to 4 (1 as most to 4 as least beneficial to the student) as regards completed presentation of instructional information.

   A. _____ slide-tape presentation (Independent Study).

   B. _____ instructor demonstration and student evaluation of instructor-prepared products.

   C. _____ student preparation and evaluation of products.

   D. _____ instructor demonstration and student evaluation of instructor-prepared products and independent study.

2. From question 1 indicate which instructional method or combination of methods (A, B, C and/or D) you feel is best suited for instruction of the following laboratory units of study.

   1. _____ bake unit (quick breads, cakes).

   2. _____ starches, eggs and custards, egg foam products, milk and cheese.

   3. _____ meats, fish, poultry.

   4. _____ vegetables, fruits, gelatin, salads, mayonnaise.

3. After observing the slides and listening to the explanations on the tapes, did you feel that, given a basic recipe, you had the knowledge to prepare the products? (Yes or No) Explain your answer.

4. A. How would you feel about taking the laboratory portion of a foods preparation course entirely by independent study (slide-tape presentation)? Comment briefly.

B. Could you have learned as much or more by the slide-tape method as by actual preparation of the products? Comment briefly.

C. How would you feel about taking the laboratory portion of a foods preparation course entirely by instructor demonstration and student evaluation of instructor prepared products? Comment briefly.

D. Could you have learned as much or more by the instructor demonstration and student evaluation method for the entire course as by actual preparation of the products?

5. **Additional Comments:**

6. **Previous Food Preparation Experience:**
   (Check one of the following):

   _____ **quite a lot**

   _____ **some**

   _____ **very little**

   _____ **none**

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