UNDERGRADUATE RESEARCH PROGRAMS AND GRADUATE RESEARCH INTERNSHIPS

by

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Teaching by means of investigative methods or internship experiences is neither innovative nor dominant in meat science education but gradually must and will command more of our attention if we are to maintain challenging and effective teaching programs. Good teaching involves the creation of a learning environment which stimulates a lifetime interest in learning, provides the tools necessary to accomplish that objective, and develops the sound foundation upon which new knowledge can build.

The concept of individualizing the educational experience and placing emphasis on active student involvement in the teaching-learning process is epitomized by this statement from the Commission on Non-Traditional Study (1973): "We are talking about an attitude that puts the student first and the institution second, concentrating more on the former's need than the latter's convenience, encouraging diversity of individual opportunity, and de-emphasizes time and space or even course requirements in favor of competence and where applicable, performance."

The importance of devoting the time and energy necessary to accomplish an effective program of undergraduate education is an ideal shared by most meat scientists, but the effort required to implement a research format as a teaching method for the undergraduate is construed by some as a misplaced or wasted expenditure of valuable time. These last statements were prompted by an evaluation of questionnaires sent to forty-two colleges or universities with meat science programs.

Thirty-six of our colleagues returned the questionnaire and shared with us many ideas, methods, concerns, and problems centering on undergraduate research experiences. Seventeen percent of those who responded were not using undergraduate research projects, and a great many who were, expressed concern as to the time and money consumed by these efforts. The benefits of such programs were, however, enthusiastically endorsed by a vast majority.

Recent graduates of baccalaureate programs have been criticized for their inability to perform in problem solving situations, for their shortcomings in planning or initiating programs, for their inability to relate and communicate research results in the decision-making process, and for their lack of awareness of how industry functions.

These concerns are important, particularly when we consider recent trends in employment and graduate study. During the last five years there has been a significant increase in the percentage of B.S. graduates placed in private industry and a slight increase in the percentage of those entering graduate study (Darrow, 1977). The last two academic year's statistics suggest the beginning of a leveling off or perhaps a decline in graduate study enrollments (LaPidus, 1977).

In addition, more students enter graduate study solely for the purpose of gaining depth relevant to a specialized area of employment or merely to plug the gaps created by either poor planning or indecision in the undergraduate program (LaPidus, 1977). We, as advisors, accept and encourage this type of student in spite of limited resources and in spite of questions and objections raised by the purist adhering to loftier goals for a Master of Science. We do so because we recognize the far reaching benefits of the research aspects of this degree's requirements, and, because we recognize the failure of undergraduate education to adequately prepare the student for the job ahead.

James (1976) reminds us that the process of reflective thinking or problem solving is the same as the steps in the scientific method. Therefore, cannot more use and more effective use of undergraduate research programs improve the value and quality of the baccalaureate experience and replace the need for a Masters program for some students, yet enhance the quality of that experience for others.

Our questionnaire results showed that only 5.7% reported less undergraduate research exposure today than in 1970, and 40.0% reported that such experiences had grown in number. Many expressed the view that use of this teaching method would increase.

The initiation of undergraduate research experi-

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ences was evenly divided between students and faculty. Surprisingly, the type of student participating included only one-third honors or pre-professional and two-thirds regular students. This makeup of students is encouraging but is probably influenced by the type of undergraduate research programs used by us as faculty.

We have many ways in which the research experience can be made meaningful for the undergraduate. Some are less expensive and less time consuming than others, but still provide the benefits attributable to learning through investigative study.

Undergraduate research experiences seem to fall into four categories: (1) research as an item requirement within a course, (2) investigation as the sole method for teaching planned subject matter within a course, (3) field or industry problem oriented group or individual studies courses, and (4) individual research projects similar to thesis problems.

Research as an item requirement within a course has traditionally involved a library oriented, paper format, involving an in-depth look at one phase of subject matter. This has been popular because it is easy to accomplish and can successfully promote the concepts of integration and expression of ideas, but it has been badly overworked and abused. An alternative, which we have used successfully, incorporates the development of oral communication skills without the sacrifice of class times. This is done by having the students prepare 20-30 minute taped reports illustrated with slides. These are complete with an outline, abstract, and bibliography. Figure 1 presents an example of guidelines for such an approach. The best of these units then becomes an excellent independent study aid for students in subsequent years.

A second example of traditional use of undergraduate investigation within a course involves the time honored participation laboratory conducted on either a group or individual basis. This uses our traditional laboratory experiment, predesigned to demonstrate a specific principle. For example, in our introductory meat course participation laboratory (six hours per week) we have students cure hams by different methods, with different materials, and record both performance and quality data over time. Completing a series of required calculations and by responding to written questions, the student prepares a report which we hope contributes to his body of knowledge concerning principles in meat curing. Kauffman (1976) is critical of grading this student report and advocates spending the time discussing what the results imply. I prefer to make the student commit himself in writing and then we can discuss the results. His motivation and interest are thereby guaranteed.

Taped Report Guidelines

If you have selected the "Illustrated Oral Presentation" as your assignment, you should research your topic as you would for the preparation of a term paper. Books, scientific journal articles, certain magazine articles, interviews, and tours are all valid information sources and should be listed in the bibliography which you will provide with your oral report.
The oral report assignment consists of the following items which are to be made available to your instructor.

1. **Outline for the Presentation**—This is to be a detailed outline from which you will give the oral report or make the tape. This outline must be shown to the instructor for his suggestions at least three days prior to the presentation.
2. **Illustrative Material**—Slides, prints, or diagrams must accompany the report since illustrated ideas are easier to comprehend. If your illustrative material is not in slide form, we will convert it for you. If you have slides and wish to keep them, we will reproduce them for our subsequent use, but this will take four days.
3. **Oral Presentation**—You will make a tape recorded presentation using our facilities. The presentation should be 20-30 minutes long. Our equipment (carrel booths) includes recording and playback units, carousel projectors, movie projector, and rear view projection screens. This will enable you to tape your presentation while viewing your own illustrative material. The equipment will permit you to pause in your presentation at any time and commence recording again when you are ready. You may also tape the presentation in segments or re-do it if you are dissatisfied.
4. **Bibliography**—A complete bibliography will be turned in to your instructor.
5. **Abstract**—A 200-word abstract or summary of the presentation will be turned in at the completion of your project. This item should explain to what the potential listener could look forward. (Written abstract)

FIGURE 1

EXAMPLE OF FORMAT FOR TAPED REPORTS

Recently, demonstration laboratories have been advocated as efficient replacements for the participation laboratory. We must remember that demonstrations deprive the student of the benefits of exploration and discovery and the stimulation of interest is not as great as "hands on" learning. Participation laboratories, admittedly meager efforts at research exposure, do stimulate interest and involve skill exposure, learning objectives and discovery, but must be aimed at a depth commensurate with understanding.

Investigation as the sole method for teaching planned subject matter within a course is a more sophisticated approach to undergraduate research experiences or investigative learning. This method might use group experimentation or individual study. Our questionnaire indicated that about 16.6% of meat science undergraduate programs use such an individual research project as part of the course requirements,

while 36.7% use the group approach. One of the respondees, however, commented that "group research is a dismal failure since students have difficulty coordinating their time for laboratory research."

Our meat science students at Ohio State are first exposed to independent, student initiated, investigative learning as a significant part of the teaching method for subject matter in our advanced meat processing course taught by Dr. V. R. Cahill. Each student, as a part of the course requirements, must submit a mini-research project proposal, which is then discussed with the instructor. These projects are oriented toward processed product development. Each student shares his results with the class and then with the university community in a display luncheon.

Dr. H. W. Ockerman (1977) uses the group technique to teach his course dealing with laboratory analysis of meat products. His stated course objectives include: (1) a working knowledge of routine meat laboratory or quality control procedures, (2) an understanding of chemical and physical properties and principles involving meat, and (3) experience in organization and personal management. To accomplish this, Dr. Ockerman divides the class into research groups or two or four members. Each team accomplishes eight major projects such as the one illustrated in figure 2. In order to also encourage creativity and independent thought and to permit the student to experience the process of individual investigation, Dr. Ockerman requires from each student an original research project and report involving some aspect quality of control.

This year a new dimension was added to the course. During the last few weeks of the quarter the entire class undertook the evaluation of product quality and shelf life for a regional pork sausage processor. Each student research group investigated two separate aspects of product composition, quality, or shelf life. Mutual benefits of such an arrangement are obvious for the academic institution and for the small or medium-sized processor and such opportunities are available. This method of teaching should be fortified by the use of graduate students or advanced undergraduate for peer tutoring. Geis (1976) points out that peer tutoring is much more than cheap labor. He emphasizes this role as one fostering a cooperative alternative to normal competitive peer situations characteristic of most classrooms.

To be an effective learning technique this total undergraduate research approach (group, individual, and class) to a subject matter course must incorporate oral reports and classroom discussion. Students must be encouraged to organize results, reach decisions, defend the conclusions, and convince their peers.

At this point in our undergraduate program the seeds of interest in investigative learning has been planted, nurtured, and are ready for the raw harvest. This harvest manifests itself in the undergraduate individual research project patterned after graduate thesis research credit. Ninety-three percent of our meat science programs include such efforts, but these are limited to very few students each year.

In our program, as in many of yours, the vast majority of these students are in the honors program and required to complete eight quarter credit hours of independent research. Our meat science faculty usually work with only about four to six of these students each year. The demand for this program by the non-honors student has been limited, perhaps either because of the adequate attention given to investigative learning in our other advanced meat courses, or, because we provide research-like problem solving experiences within our academic internships in the meat industry which is becoming more popular.

Another reason was suggested by a study of 800 men and women from the University of California, Berkeley, by Morstain (1971) who reported that more students in the physical sciences than in the behavioral sciences felt that their educational objectives could best be met through formal courses, lectures and exams. Of greater significance in this study, was the fact that 40% of the students in the "hard" sci-

Animal Science 651
Winter, 1977

Group ..... Date .....
Group Captain ..... Project No. 36

Group Members .....

.....

Project Title: Relationship Between Emulsifying Capacity and Fat and Moisture Content in Beef

Project Purpose: To observe the above relationship over a range of fat and protein compositions

1. Obtain 3 samples of beef (approximately 10%, 25%, and 50% fat)
2. Run protein and fat analysis on a representative part of each sample
3. Run an emulsification capacity on the remainder of each sample
4. Plot data on a bar graph as shown on page 240.0G

FIGURE 2

EXAMPLE OF ONE OF FIFTY GROUP INVESTIGATIONS FOR H. W. OCKERMAN'S COURSE "LABORATORY ANALYSIS OF MEAT PRODUCTS"

ences and technical fields opted for an independent study approach to their education.

The benefits of undergraduate, individual research, planned, executed, analyzed, reported, and defended by the student, are in complete accord with the modern concept of the obligation of educators. Flanigan (1970) writing as an educational psychologist emphasized that education must provide the student with "a reasonable degree of skill in analyzing and defining problems, in developing alternate solutions to these problems, and in using various types of evaluative procedures to choose from among the possible solutions in an effective manner." He further states that education should "include the ability to prepare a sequential plan using a clear statement of desired outcome and working back to obtain a definite schedule and a set of procedures for determining the required progress at each point, if the plan is to be realized."

I believe that the undergraduate individual research project does the best job of permitting the student the opportunity to test these skills. While these individual projects may involve a laboratory oriented experience or a library experience, 72% of our meat science programs using this project method, combine library and laboratory work as in the thesis work at the graduate level.

Once we move the student into the laboratory, material costs mount and add significantly to the costs in professional time. Getting funds for these increasingly popular individual projects is becoming a major problem.

The questionnaire results indicate that 44.7% of our undergraduate meat research projects are absorbed within existing teaching funds but that 45.3% are absorbed within existing research project funds. We at Ohio State find this latter situation very difficult and potentially damaging. We must all explore other alternatives. Bob Kaufman (1973) of Wisconsin finances his undergraduate small group research topics, market-oriented course with small industry grants. He suggests a yearly budget of $3-5,000. Gene Allen reports that the University of Minnesota has a competitive program for undergraduate project funds. Successful projects receive up to $250 to be used for the project. Our own program rewards the student with $900 scholarships but fails to provide anything for material project expenses. Administrators must be convinced that these undergraduate research programs cannot be promoted and publicized without designated financing. Only 8.5% of our colleagues have such designated funds. Perhaps our own American Meat Science Association should look at a competitive undergraduate research project award rather than at a traditional scholarship program.

Faculty time, a critical ingredient in the success of this undergraduate research program and yet a major concern to faculty participants, might be used more efficiently. Don Kinsman in his questionnaire response strongly recommended a printed prescribed format, outlining procedures and student responsibilities consistent for all students. He feels that this is an equalizer and time saver, and I must agree with him.

Adequate preparation on the part of the student is essential before the process can begin. Prior completion of a basic science program, meat science curricula, and supporting food science courses is a must, but I believe that a basic course in statistics (through regression techniques and analysis of variance) followed by a course in computer operation and programing is equally essential. At Ohio State this involves ten quarter hours of course work, a part of which can be completed while the project is in progress.

Normal timing would suggest that the project is best accomplished in the senior year, but the search for the project idea and the ultimate project proposal should be completed during the junior year. We insist on a formal project proposal containing a statement of objectives, reasons for the study, literature review, design and procedures, and an accompanying bibliography.

Project selection can be handled in two ways. The project idea can be handed to the student either as on a "silver platter" or by subtle guidance. Many would argue that this method guarantees the best use of money and time, but we all recognize that the student search for the project idea and the subsequent development of a hypothesis and project plan are absolutely essential items in this educational format. We therefore choose this latter method. The process usually begins for us with an extensive reading program as a means for narrowing the field to a few specific areas of interest. After many consultations and discussions with the faculty advisor, the choices are narrowed and the proposal formulated. If this is done independently with only a half dozen students in a year, much faculty time is used and perhaps not efficiently.

There is no reason why group sessions could not be utilized for much of the literature discussion and project search. In fact, Ainsworth (1976) suggested that the small group approach is the most desirable

method for developing skills such as evaluating, analyzing, and testing of hypothesis. This group approach could continue for discussion of methods for recording data, card formats, analysis choices, etc., during the investigative phase of the project.

It has been suggested that during the investigative phase of the project, graduate students be used to provide attention and support in a mutually beneficial peer tutoring mode. Informally, we have observed this happening and have at least formalized this approach for the computer analysis phase of the project. Much individual faculty attention is needed once the statistical data is available, because the undergraduate student requires more guidance than a graduate student when interpreting results and integrating these with previous literature.

The group can again be brought together for discussions of results, report requirements, and writing problems. We require both a thesis-type report and an oral exam, but the majority of our meat science programs require just a written report. Thirteen percent mention a thesis type write-up while one-third percent require an oral exam. It is important that the student be required to effectively communicate his results and to defend them.

The undergraduate research approach, regardless of what form it takes, is admittedly more tedious and time consuming for faculty than the same investigative teaching with graduate students. The undergraduate lacks the maturity, has more scheduled class time and activities, and often lacks the discipline or motivation of the graduate student, but, therein lies the challenge.

With these undergraduate projects we are able to reap some real benefits. Many of these students will pursue graduate study and will be better qualified because of these experiences. We in turn have an opportunity as Dale Huffman (1977) put it, "to use undergraduate research performance to determine a student's aptitude for graduate work." We have participated and encouraged the development of a person who can at the Baccalaureate level better:

1. identify a problem
2. ask the right questions and develop a hypothesis
3. efficiently obtain information in the investigation of the problem
4. integrate previous knowledge with current findings
5. reach supportable conclusions
6. communicate effectively and defend the conclusions

The committee has asked me to briefly discuss with you the idea of graduate student research internship. With research and associateship funds limited nationally and because more students have seen fit to engage in "defensive credentially" with a Master of Science degree for employment reasons, our meat science graduate programs have been experiencing more "home-grown" students.

Many of these students plan to enter the meat industry through quality assurance or research and development jobs. Industry research approaches are often quite removed from the academic laboratory program, and there is a need for exposure of these graduate students to laboratory variety experienced within industry.

Our research internship program began innocently enough in 1974 through Dr. H. W. Ockerman's many years of active participation in the European meat research conferences. Herb had toured many of the industry-oriented meat and food government research laboratories such as those in the Netherlands and Sweden and constantly received invitations to visit and discuss research work of mutual interest. One such visit in 1974 prompted a request on our part for tumbling data generated at TNO in Zeist, Netherlands and at the University in Utrecht (Central Institute for Nutrition and Food Research). Dr. Bernard Krol indicated that this data was not available for release or publication because of the industry research format of the institute, but he invited us to send a graduate student to study with him that summer and experience their research program.

The idea was intriguing. Why not a research type internship for a graduate student? (We promote, but at Ohio State can't get, sabbatical leaves for a faculty.) The potential advantages were many:

1. exposure to industry-oriented research
2. exposure to research as the single activity
3. exposure to new people in an international setting
4. exposure to new laboratories and procedures
5. exposure to different equipment
6. exposure to produce development emphasis
7. and the intangible benefits of people in another cultural setting

Our first such internship was very successful. Mr. Ray Krause, now with Union Carbide, spent the sum-

mer of 1975 at TNO in Zeist, The Netherlands, working with Dr. Krol. Original plans established that Ray's research in the tumbling area would be carried out in two phases. The practical phase to be carried out at TNO with the theoretical phase (cure migration rates as influenced by PO4 and tumbling) to be completed at OSU upon his return in September. All statistical analysis and subsequent interpretation of results were completed at Ohio State University.

In the summer of 1976 Mr. Rick Cassidy, also now with Union Carbide, participated in this program, but spent considerably more time at the University of Utrecht, The Netherlands. Rick was working with histological changes in tumbled products in the Institute for Food of Animal Origin.

Both internships involved token salaries, large enough to cover living expenses, but transportation was the student's responsibility. Living quarters were provided which resulted in exposure to other visiting researchers, deans, and post-doctorate people from many countries.

In the opinion of both participants, the experience was one of immeasurable value. We the faculty advisors at Ohio State are enthusiastic about the results when measured in terms of student value and development and when evaluated in the context of international exchange of research ideas and methods. Dr. Krol indicated surprise at the level of competency and, even industry, skill displayed by each man when measured against the Dutch meat science student, and he indicated that each participant made definite contribution to the TNO research program.

Our fourth graduate research intern leaves for TNO this morning. Our third left for NORDRECO AB (Research, Development, and Technical Assistance in Agriculture Production and Food Processing) in Sweden on June 6 to participate in a research study involving tenderization methods.

There are some drawbacks to such a program. Every student cannot gain value, and your judgment must be based on student competency, experiences, motivation, and career goals. Participation may add one quarter to the time necessary for completion of the Master of Science degree. Pre-planning is an absolute requirement, particularly in the area of research design and needs as related to proper interpretation of results and sufficient data for a guarantee of repeatability.

With these results behind us, we would like to propose the development of such federal or industry laboratory research internships at the graduate student level through our American Meat Science Association. Laboratory participants in such a program would have the opportunity to look over potential employees a year before the fact. At the very least, these cooperators would receive replacement vacation help, and the program would further develop close ties between the academia and the industry with which we associate. Problems needing basic research effort would be more rapidly identified for us, and cooperative research efforts would become more practical. But, perhaps of greatest importance, industry would play an active role in the process of education and could assist us in identifying and perpetuating the qualities of leadership necessary for tomorrow's success.

Improvement in our approach to undergraduate and graduate education is important, because many of us can make a greater contribution to mankind's knowledge through the minds we help develop than we might ever individually make through our own research.

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