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Undergraduate Research Projects as a Teaching and Learning Device

Steve Blank

An existing program which has incorporated undergraduate research projects into its curriculum is evaluated. The goals of the program are to provide students with opportunities to apply their newly acquired skills to real problems and, in so doing, to gain specialized familiarity with a topic and/or occupation. The results of the program have been good, in general, despite some limitations. The conclusion reached is that the program offers many short and long run benefits to students in that it improves their performance both in the classroom and in their career positions.

The purpose of every teaching device is to improve the education received by students. Many techniques are used in agricultural programs today [Kendrick]. Undergraduate research projects (URP) are a relatively new teaching device added to college curriculums in the field of agricultural economics. A research requirement has long been thought to be a vital part of most graduate programs in agricultural economics, but it has been felt that many students in undergraduate programs are unprepared to successfully complete a research project of their own [Kolb, Roberts and Lee]. Undergraduate programs have been viewed as the place where students are given the tools of analysis relative to the discipline. There are so many courses required of a student in an agricultural economics or agribusiness undergraduate program that there is often little or no time for extensive application of those tools [French, Boehlje and Eidman]. Yet, Roberts and Lee concluded that with the particular learning processes of typical students which major in agricultural economics, instructors should use teaching techniques that rely less on intuition and reading and more on sensing and factual materials.

The purpose of this paper is to discuss the value of introducing applied research projects into undergraduate programs as an additional device to be used to increase the value of those programs to students. An existing URP program will be evaluated as an example of this type of teaching device. The evaluation process will follow the precedent set by Trock and House for studying training programs in agriculture. Trock and House used the educational impact model developed by Joyce and Showers as a basis for evaluating the contents and effectiveness of such a program.

Joyce and Showers state that when students use what has been learned to solve problems they are demonstrating that their training has had the highest level of impact possible. The level of impact a program will have, in turn, is affected by the following training components:

1. Presentation of theory or description of skill or strategy;
2. Model or demonstration of skills or models of teaching;
3. Practice in simulated and classroom settings;
4. Structured and open-ended feedback;
5. Coaching for application.

Joyce and Showers indicate that components 1 through 5 above have increasingly greater levels of impact on students' abilities to solve problems. When included in a training program, coaching is shown to dramati-

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cally increase the number of students that are able to apply what has been learned (up to 75% of the total number of students). Therefore, a successful URP program that includes all five of the training components listed above could result in assuring that approximately 75% of students can apply their newly acquired problem-solving skills.

The Goals of Research Projects

The purpose of an URP is two-fold: (1) to provide opportunities for students to "learn by doing", and (2) to make it possible for students to gain specialized familiarity with a topic of interest to them. These goals are similar to those used in support of off-campus internships [Snodgrass, Manderscheid and Ferres].

The first purpose of an URP is to increase the level of learning beyond the classroom by allowing the student to apply skills learned in the formal coursework to real problems. This "real world" exposure can provide insight into working situations that could never be completely simulated in a classroom. Students can develop greater appreciation for the decision making process in this way.

The second purpose of an URP is to give students a chance to explore a problem/topic area without the ties of actually being employed or without the performance and time commitment of a formal internship. An URP can be labeled a "student-designed course" in which the student works closely with a faculty member to investigate a subject in detail. This gives the student a chance to encounter problems that overlap the contents of two or more courses, providing them with an opportunity to see how the curriculum blends together into a single body of knowledge.

A Sample Program

At California Polytechnic State University, San Luis Obispo (CPSU), an URP program has existed since the school's beginning. The program of the Agricultural Management Department will be analyzed in this paper as an example of this type of teaching device.

The program at CPSU calls for each student to complete an individual URP as a requirement for the Bachelor's degree in Agricultural Management. The work is to be completed over the period of one academic year through enrollment in three courses, each lasting one quarter. The courses are taken during the last 3 or 4 quarters of the undergraduate program. The first quarter includes a 3-unit lecture course covering research methods. In this course students are introduced to the scientific method, problem identification, objectives and hypothesis formulation, and given a survey of relevant data collection and analysis techniques. The coursework of the research methods class includes case assignments completed by teams and concludes with the preparation of a proposal for the URP. During the following two quarters the actual work is done for the URP and a formal written report is prepared. The work is supervised by a faculty member chosen for his ability to assist in the specific topic area. The work is done by a student on an independent study basis. The student receives 2 units for of the two quarters of work. This makes the total value of the URP 7 units of the 198 required for graduation.

The project proposal written by a student must be reviewed and approved by a 3-member faculty committee before the research work begins. The proposal written for the research methods course is submitted near the end of the first quarter for review. The faculty committee evaluates whether the topic is appropriate in type and scope and whether the student has a sufficient level of academic preparation for a project on that topic. Typical projects undertaken involve developing a feasibility study for a new agricultural firm or doing a complete farm analysis. In preparation, a student must have completed a short list of courses specifically required for the chosen topic. Upon favorable project review, the committee assigns students to faculty advisors. This process assures that URPs require students to undertake a strenuous problem-solving type project. Therefore, an URP is significantly dif-

ferent from other "independent study" courses offered at CPSU.

Analysis of the Program

The URP program of the Agricultural Management Department of CPSU includes all five of the training components listed by Joyce and Showers. The first three components are met by the research methods course. The theoretical strategy to be used in problem solving (the scientific method) is presented in a lecture format. Problem solving skills are demonstrated through classroom discussion of cases. Problem solving is practiced through simulated cases analyzed by teams of students outside of the classroom. The fourth training component is met during both the research methods course and the actual research process. Structured and open-ended feedback is given to a student by both the instructor and the project advisor. The fifth training component, coaching for application, is fulfilled by the project advisor during the two-quarter research period.

To analyze the value of an URP as a teaching and learning device, the major benefits and costs of such a program will be considered first. These involve evaluations made by students and/or faculty that have participated in the program.

Four general benefits of an URP program have been identified over a period of years at CPSU. All have immediate and long range effects on students. These benefits are illustrated by the findings of three surveys of students taken by the Agricultural Management Department at CPSU. The three groups surveyed were (1) students in the last quarter of their URP, (2) students that had completed their URP, and (3) former students that had graduated 1 to 5 years earlier. The information gathered during the surveys is presented in Table 1.

The first beneficial result observed is that URPs help demonstrate to students that they can truly solve real problems. This observation is based on the data presented for items 1, 2, and 3 in Table 1. Of those former students responding to the question "Do you believe that your URP improved your problem solving skills?", 83% gave positive replies. A clear majority of former students also believed that the research methods course both improved their ability to complete their URP (93%) and gave them skills for use on their job (76%). It is interesting to note, however, that the level of positive responses for these items (as well as the others in the surveys) was lower for current students. All alumni surveyed had a more positive attitude about their URP after leaving school and being able to put the project into the broader perspective which comes with work experience. Therefore, the responses of alumni can be considered true *evaluations* of the URP program, while the responses of students involved currently in their project must be considered *perceptions*.

The significance of demonstrating to a student that he/she can solve real problems is wide-ranging. Students take pride in the fact that they completed an URP — a major accomplishment. In many cases it may be the first large undertaking ever completed by the student. Even if difficulties arose during the project, there is a positive long-run boost to the student's confidence at knowing he succeeded in the end. This is evidenced by the responses received for item 4: the question "Are you proud of your completed URP report?" A majority of both alumni and current students responded positively — 79% and 77%, respectively.

The second favorable attribute of the URP is that it allows for individuality of students and their college programs. As indicated by the results for item 5 in Table 1, undergraduates recognize that they can have some input into their own education. The URPs let students get more involved in a topic area of interest than is possible with the standard course contents of most agribusiness programs. Faculty note that a student's enthusiasm for the "self-designed course" will often carry over into other classes.

The third positive result of the URP program is that it can provide special training in the subject area of employment interest. The

TABLE 1. Student Evaluation of URPs[a]

Item	During URP[a]	After URP[b]	Alumni[c]
1. Do you believe that your URP improved your problem solving skill?	56%	68%	83%
2. The research methods course improved my ability to complete my URP.	83	91	93
3. Skills learned in the research methods course can be used on my (planned) job.	56	72	76
4. Are you proud of your completed URP report?	--	77	79
5. An URP allows for individuality in the college program.	78	83	85
6. Did your URP experience influence your choice of careers?	50	69	71
7. Did your URP impress your (prospective) employer?	56	67	74
8. Was your knowledge of the URP topic expanded by your advisor?	45	56	61
9. Individual contact with an advisor is essential in the URP program.	94	96	96
10. URP's time requirements are reasonable.	33	40	57
11. Was your URP experience valuable to you?	56	68	82
12. An URP is an important part of the curriculum and should remain as a requirement.	56	80	91

[a]Data represents percentage of positive responses received. The choices offered to respondents were: agree/neutral/disagree for items 2, 3, 5, 9, 10 and 12; and yes/neutral/no for items 1, 4, 6, 7, 8 and 11. Sample size: (a) 62, (b) 67, (c) 86.

URPs do not get jobs for people not otherwise qualified, but they do help students make career choices and demonstrate their talents. It is often the case that students choose to do their research on some aspect of their anticipated profession. In doing so, students learn more about whether the specific company or industry will actually satisfy their career ambitions or, more importantly, whether the job they anticipate applying for after graduation is truly what they want. The favorable responses to item 6 indicate that URPs aided many people in making their career choice. In many cases not only do students find that they like what they see upon this first investigation of a career field, but they also use their completed research reports as part of their job application package. One example was a student that had discovered a career interest in agricultural marketing while taking the required course covering that topic. During job interviews the student presented copies of his completed project on the subject to prospective employers and impressed Continental Grain enough for them to hire him immediately upon graduation and to give him a premium above their normal starting salary offer. The responses to item 7 demonstrate the frequency that URPs aid in the employment process. It is noted, however, that the differences between current students and alumni in their responses to questions 6 and 7 indicate that the passage of time improves the perspective needed to evaluate the true impact of URPs.

The fourth general benefit of the URP program is that it provides one of the few chances for a student to meet on an individual basis with a faculty member. With class sizes increasing, the amount of direct feedback (coaching) a student receives from faculty members is decreasing. Due to this trend many students express satisfaction at having a chance to talk in depth about many subjects

with a teacher. The information presented by items 8 and 9 in Table 1 illustrate this point. While students were mixed in their opinions concerning the educational aspects of contact with an advisor (item 8), nearly all students agree that individual advisor contact is essential to the URP and should be continued (item 9). This close contact also provides both student and advisor with a chance to know one another better, which adds to the level of understanding between the two. The relationship that develops is often similar to that between graduate student and thesis advisor.

Some limitations in the URP program have been identified at CPSU. These limitations, or costs, fall into two general categories.

The first limitation of the URP program as it has been run at CPSU is that it requires a great deal of time on the part of students. The minimum amount of time required to successfully complete a project has been 120 hours over the two-quarter period following completion of the research methods course. This means a minimum of about six hours per week for which the student earns only 2 units of credit per quarter. This can be a drain on some students because they must usually devote much more than the minimum amount of time to an URP. It is also argued that devotion of seven units to a single project is too great an emphasis on research in an undergraduate program. Some opponents have said the time and units could be better spent or simply dropped all together to ease graduation requirements somewhat. The results for item 10 in Table 1 indicate that most current students believe URPs require too much time, yet alumni disagree slightly.

As would be expected, time constraints of the URP program affect the quality of projects completed. Some projects are of Master's thesis quality, but on average the quality of completed projects is good, not excellent. This is illustrated by the following breakdown of grades given to students at the end of the two-quarter research period:

A — 26%
B — 19
C — 15
D — 7
F — 15
Inc 18
100%

Also as expected, the correlation between grades received and the responses to item 4 is very high; nearly all responses indicating that a student was "proud" of his report came from students which recieved an "A", "B", or "C" grade, while only one positive response came from the recipient of a "D" grade. A few students with a grade of "C" did indicate that they were not proud of their finished report. (Nearly all "Incomplete" grades become a "C" or better when the project is finished.)

The average length of completed URP reports is about 60 double-spaced pages, which includes all tables, appendices, and support materials. A project of this scale often requires more time than inexperienced undergraduates expect, which leads to the high percentage (18%) of Incomplete grades issued. Due to the definite time deadline requiring all projects to be completed within two quarters, it is difficult for an advisor to gradually move the student to a successful conclusion, as is done in a graduate thesis program. The work must be turned in at the end of the second quarter and a grade must be given. This often leads to a paring-down of the original project because some problems arose that delayed progress long enough that time constraints forced adjustments or total cancellation of portions of the planned work. Obviously, this reduces the quality of the completed project as well as the value of the URP program for some students.

Consistency in the URP evaluation and grading process is maintained with the use of two devices. First, the AM department has prepared a manual which provides a detailed description of the required URP report format, examples of minimum content requirements, and an explanation of the evaluation process itself. Each student is required to read and use this manual beginning in the research methods course. The second device used by faculty is a weekly schedule which

specifies what progress is expected of the student throughout the two-quarter research period. This schedule is tailored to the student and the topic. Using these devices, the faculty is able to establish a standard of performance while recognizing differences between topics. Consistency is maintained within topic areas by assigning all projects of a like nature to advisors which specialize in that subject.

The second limitation of the program is the necessary time commitment of faculty members. The average amount of time a faculty member spends with each advisee can be as high as one hour per week, depending on the subject of the project and the abilities of the individual student. This means that each faculty member teaches fewer lecture courses because their workload includes supervision time for URPs. This can compound other problems such as overcrowding in the courses that are offered. Clearly, critical constraints on the success of an URP program are faculty attitudes and their willingness to devote the large amounts of time required. Without total faculty support of the program, students will vie for assignments with supportive instructors and eventually the whole program will fail.

Conclusions

The URP program of the Agricultural Management Department of CPSU is considered to be a success. Also, the general conclusion of this evaluation of URPs is that they can be a valuable teaching and learning device.

The short and long range benefits derived from this program far outweigh the costs and limitations. Helping to bridge the gap between college and the working world, URPs give students opportunities to express themselves that would not be available to them in the normal college curriculum. Even more important, students are better able to use their newly acquired skills when the URP learning device is implemented. This is evidenced at CPSU by the response of alumni indicating that they are using their URP talents on the job (item 1).

The most convincing argument for this program, however, is its support from former students that have had an opportunity to evaluate the effects of the program from a broader perspective. Items 11 and 12 in Table 1 indicate the general level of support for the program. Item 11 shows that 82% of alumni responded positively when asked whether the URP was a valuable experience for them. Item 12 indicates that 91% of former students agreed with the statement that an "URP is an important part of the curriculum and should remain as a requirement".

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