IMPROVING LEARNING WITH MASTERY LEARNING

Henry D. Foth

Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824.

After an extensive review of the literature, Dubin and Taveggia concluded that "we cannot claim superiority for any among the different teaching methods used to convey subject matter" (2). This paradox between teaching and learning is related, in part, to the fact that each class is composed of learners with different aptitudes for learning. Some students learn best with one method, others learn best with other methods. Any particular teaching method tends to produce grades that are somewhat normally distributed. When the teaching method is changed, there tends to be a similar grade distribution, however, the grades that individual students receive may change. If, on the other hand, a class is given a variety of opportunities to master or learn the material, more students are likely to earn high grades. This happened with the integrated experience approach to learning developed by Postlethwait, et al. (3). Increased learning with audio-tutorial programs has been expressed in a need to upgrade courses that normally follow in the same subject matter area.

Even though a wide variety of learning opportunities are provided, a large reservoir of potential learning may remain untapped. Perhaps, the greatest opportunity to increase learning is to put into operation principles that are known to facilitate learning regardless of teaching method. This includes making available to the learner knowledge of what is to be learned (objectives) and knowledge of progress toward mastery (feedback). Learning is also enhanced by an opportunity to correct errors and to engage in additional learning (remediation) and evaluation relative to an absolute standard of performance rather than the relative standard based on the learning of other students. This paper discusses a format for mastery learning that the author found successful and the results in terms of student learning, program effectiveness, and student response.

Development of a Mastery Learning Program

After an audio-tutorial learning center program for an introductory Soil Science course had been in operation for several years, an attempt was made to encourage students to master the objectives. Criterion-referenced tests, exams with questions keyed to objectives, and a straight grading scale were introduced. Students were encouraged to master the objectives and earn A grades, but, nothing happened. Gradually, retest opportunities and self-tests for feedback were used, but still little success was achieved in terms of an increase in learning.

After having had several years of experience with various efforts to increase learning, some new strategies were developed just prior to the winter term of 1972. As a consequence, a mastery learning program was developed which included the following changes or features.

1. Two criterion-referenced self tests for each learning center unit or minicourse, instead of one, to provide for more feedback and opportunity for remedial learning.
2. Five exams instead of 4. Less content for each exam makes it easier for students to achieve a high level of competency.
3. The first exam was given at the end of the first week, rather than the second, to get students quickly involved and, hopefully, experience a high level of achievement early in the course.
4. Retest opportunities throughout the term as contrasted to only at the end of the term.

Many things remained the same as those of the previous term, when efforts to increase learning were quite unsuccessful, and knowledge of some of these is important in evaluating the outcome of the mastery program. These included the course content, tutors, use of final exam period to retake 1 or 2 exams for the third time, and examination procedures. At exams students turned in a machine scoring sheet and kept the exam questions. Answers to the questions were provided in the lobby adjacent to the exam room. Students immediately scored their papers and determined their grade. I spent a considerable amount of time circulating among the students in the lobby and answered many questions about the exam while the questions were fresh on the minds of the students. In this way the exams provided both feedback and a learning experience. The class grades were posted in the learning center after each exam and students were informed of the progress of the class throughout the term. I did everything I could to encourage learning through mastery of the learning objectives.

Grade Changes with Mastery Learning

A marked improvement in both grades and student responses occurred in winter 1972 as compared to fall 1971. Grades for five terms, two terms before (F70, 71) and three terms after (W72, F72, F73) the mastery learning program became successful, are given in Table 1. The percentage of grades B or above increased from about 50 to 90 percent. The marked improvement in grades was associated with evidence that the students learned more and that the use of techniques to increase learning were successful. The evidence for more learning will be discussed next.

Table 1
Grade Distributions for Five Terms

Grade	Minimum %	Term F70	F71	W72	F72	F73
4.0 or A	88	24	24	70	53	55
3.5	84	12	10	10	17	17
3.0 or B	78	15	24	10	17	15
2.5	74	10	12	3	4	6
2.0 or C	70	18	15	1	4	4
1.5	66	10	2	2	1	2
1.0 or D	62	5	4	1	1	<1
0.0 or F	-	6	9	2	3	<1

Evidence for More Learning

Evidence other than grades was obtained relative to a change in learning. During the last week of the term, students were asked to respond to an opinionaire designed specifically for the course and the all-university Student Instructional Rating System (SIRS). About 70% of the students were present and participated in the evaluation. The first eight items of Table 2 relate to evidence that more learning occurred in the winter 1972 compared to fall 1971. Students in the winter 1972 felt that they learned a great deal more in the course, became more competent in soil science and were challenged more intellectually (item 1, 2 and 3). More time was spent on the learning center program and fewer learning center units were missed (out of a total of 18 units). Since learning is enhanced by interest in the subject, items 6 and 7 provide indirect evidence for the likelihood of greater learning. Finally, students felt that the course organization in winter 1972 resulted in learning *that would be* remembered for a longer period of time (item 8).

Student Response to Techniques Designed to Increase Learning

It is believed that the marked difference in student performance in winter 1972, compared to fall 1971, was due to the more effective use of objectives, feedback, remediation and evaluation techniques. Items 9-17 in Table 2 provide some feedback concerning student response to the use of these techniques. The objectives in winter 1972 appeared to be only slightly, if any, more useful (item 9). It is well to realize, however, that no change in the objectives occurred between the terms and lack of positive response to usefulness of objectives in this case is not surprising.

Although there were 2 self-tests for feedback in winter 1972

Table 2
Student Response to Questionnaires

Item	Term	Percentage response* 1	2	3	4	5	Ave.	Significance of difference**
1. I learned a great deal in this course.	F71	32	48	10	7	3	2.01	.1%
	W72	53	40	5	2	0	1.56	
2. I have become more competent in this area due to this course.	F71	31	53	9	4	0	1.86	1%
	W72	42	54	1	2	0		
3. I felt that this course challenged me intellectually.	F71	9	55	23	9	1	2.38	.1%
	W72	42	54	1	2	0	1.62	
4. On an average I spent the following time per week to complete 2 units (preparatory reading plus learning center program plus homework problems): (1) 1-2 hours, (2) 2-3 hours, (3) 3-4 hours, (4) 4-5 hours, (5) over 5 hours.	F71	13	41	27	13	6	2.58	.1%
	W72	8	22	31	20	19	3.20	
5. The number of units I didn't do was: (1) none, (2) 1, (3) 2, (4) 3, (5) over 3.	F71	80	6	8	3	3	1.43	5%
	W72	91	4	2	0	3	1.20	
6. I was interested in learning the course material.	F71	24	62	7	6	1	1.97	1%
	W72	40	56	3	1	0	1.64	
7. Listening to tapes became tedious.	F71	6	26	16	48	4	3.18	1%
	W72	4	13	20	51	12	3.54	
8. The organization of the course results in learning that will be remembered for a longer period of time.	F71	12	45	30	7	6	2.50	5%
	W72	20	48	25	4	3	2.22	
9. The objectives listed at the beginning of each learning center unit were useful.	F71	18	50	25	6	1	2.22	N.S.
	W72	22	56	12	9	1	2.11	
10. I completed the following number of self-tests: (1) none, (2) 1-30%, (3) 31-60%, (4) 61-99%, (5) all of them.	F71	6	9	9	19	57	3.55	.1%
	W72	6	2	2	10	80	4.56	
11. I believe the self-tests improved my grade.	F71	48	33	10	4	5	1.81	.1%
	W72	75	18	1	3	3	1.41	
12. The average amount of time I spent to prepare for a retest was: (1) less than ½ hour, (2) ½ to 1 hour, (3) 1 to 1½ hours, (4) 1½ to 2 hours, (5) over 2 hours.	W72	8	22	24	19	27	3.35	
13. I learned a significant amount in preparation for retests.	W72	35	41	9	11	4	2.08	
14. This course provides more opportunity for student-faculty interaction.	F71	9	45	30	13	3	2.56	1%
	W72	20	48	23	8	1	2.22	
15. Knowing in advance that a certain test score would result in a particular grade caused me to study more (than if exams had all been curved as is the usual case).	F71	13	28	22	28	9	2.92	.1%
	W72	36	29	13	19	3	2.24	
16. If I had my choice, I'd prefer no retests and give grades according to the curve.	W72	0	3	7	31	59	4.46	
17. If I had my choice, I'd prefer grading on a pass-no grade basis as compared to present system.	F71	12	12	19	31	19	3.19	1%
	W72	12	10	9	37	32	3.67	
18. I would like to see other courses taught using these techniques.	F71	34	36	19	6	5	2.12	.1%
	W72	58	33	6	2	1	1.55	
19. Self-instruction as used in this course results in less efficient use of students time.	F71	6	3	14	39	38	4.00	1%
	W72	2	3	3	36	56	4.41	
20. The course was well organized.	F71	31	51	12	4	2	1.96	1%
	W72	43	51	4	2	0	1.65	
21. The instructor seemed to be concerned with whether the students learned the material.	F71	42	48	7	2	1	1.73	1%
	W72	68	29	3	0	0	1.36	

*In items such as 4 and 5 the percentage response is for specific categories, as in number 4, time in hours. In other cases response is as follows:
(1) I strongly agree with this statement,
(2) I agree with this statement,
(3) I am uncertain about this statement,
(4) I disagree with this statement, and
(5) I strongly disagree with this statement.

**Level of significant difference of averages as determined by test.

and only 1 in fall 1971, students in winter 1972 had a much higher percentage of completion of self-tests. There was also a much greater belief in the effect of self-tests on grades in winter 1972 (item 11).

Remediation is considered here to consist of the time and effort spent on retesting. Twenty-seven percent of the students in winter 1972 indicated they spent over 2 hours in preparation for retests with 35% strongly agreeing and 41% agreeing that they learned a significant amount in preparation for the retests (items 12, 13). There are no comparisions with fall 1971 because retests throughout the term were first used in winter 1972. Evidence that might be supportive of more effective remediation by greater use of learning center tutors is indicated by a feeling that the course provided more opportunity for student-faculty interaction in winter 1972 (item 14).

The use of an absolute grading scale in this program appeared to be a major stimulus to learning. Thirty-six percent strongly agreed and 29 percent agreed to the statement that "knowing in advance that a certain test score would result in a particular grade caused me to study more" (item 15). The differences between the two terms was significant at the 0.1% level. Students overwhelmingly rejected the idea of no retests and use of a curve in the course. The 59% strong disagreement to the statement "If I had my choice, I'd prefer no retests and give grades according to the curve," is unusual in the sense that 59% strong agreement or disagreement is unusual. In the fall of 1972, however, the comparable percentage was even higher. 64.

Item 17 is interesting in showing the importance of a regular grading system as a stimulus to learning compared to a pass-no grade system. It is my belief that assignment of grades on the basis of individual achievement is, perhaps, the most powerful technique teachers have to increase learning if opportunities are available for students to achieve mastery. In the fall 1973 many students who already had an A on the first exam, retook the exam which resulted in 10% of the students in the class achieving a "higher" A. I suspect that success in any conscious endeavor feeds the self-image and improves one's attitude toward one's self, resulting in great interest by students in working harder to achieve success if the proper learning contingencies are available.

General Response to Mastery Program

The response of students to the audio-tutorial program was complementary before the mastery format was introduced. For example, 73% of the students agreed that they "would like to see other courses taught using these techniques" as early as fall 1969 and in the fall 1971 it was similar (70%), yet, in winter 1972 the percentage was 91% (item 18). Briefly, from a comparison of response for winter 1972 with fall 1971 it appears that the mastery learning format resulted in (1) increased learning efficiency (item 19), (2) better course organization (item 20), and a belief that the instructor was more concerned with whether they learned the material (item 21). Item 21 was a part of the all-university Student Instructional Rating System and, in comparison with other courses in the college, the percentile rating increased from 66 to 91 from fall 1971 to winter 1972.

Enrollment Changes

The enrollment for the fall terms of 1969-73 is given in Table 3. An enrollment increase occurred in 1971 that coincided with about a 10% enrollment increase in the College of Agriculture and Natural Resources and intensive efforts to perfect the mastery learning program. The large increases for fall 72 and 73 are believed to represent a response of students to the course after the mastery program became successful. During the last 2 years many of the colleges in the university had enrollment declines, however, the enrollment from outside colleges increased both numberwise and percentagewise. The number of outside colleges represented increased from 4 to 12 between 1969 and 1973. The percentage of students in the course who had had the course recommended to them by another student increased from 13 to 34% between 1970 and 1973.

Table 3
Enrollment Data

	Fall Term				
Enrollment	69	70	71	72	73
Course total	145	138	204	306	404
Outside College of Agriculture and Natural Resources					
Number	11	23	31	53	81
Percent	8	17	15	17	20
Colleges represented	4	8	9	12	12
Percent recommended by another student		13	15	36	34

Summary

Providing students with learning objectives, opportunities to master the objectives, and evaluation based on individual achievement resulted in more learning. In addition, the students responded more favorably to the course in terms of opinionaire response and course enrollment.

In discussing the effective consequences of school achievement, Bloom states that "each individual seeks desperately for some positive signs of his own adequacy and worth" (1). I believe the mastery program provided students an opportunity to foster their self-concept by providing an opportunity for high achievement relative to an absolute standard and increased competence in Soil Science. Fostering the student's self-concept, likely, provided the motivation for greater learning. It appears that mastery learning programs can create a complimentary relationship between two of the most important aspects of education, namely, learning subject matter and development of an adequate self-concept.

References

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AN EVALUATION OF THE AGRICULTURAL HONORS PROGRAM AT THE UNIVERSITY OF NEBRASKA

Vernon Williams and Franklin Eldridge

Honors Programs were established on a wide scale in American colleges and universities after the Second World War. Even now, three decades later, an honors program in a College of Agriculture is still more the exception than the rule. Almost equally rare is the evaluation of Honors Programs (Nunnally, 1959; Pilisuk, 1959; Graf, 1962; Ellis and Marquis, 1964; Rochford, 1964). MacLeod (1964) and Tyler (1964) have outlined an approach to Honors evaluation which involves: 1) a search for criteria, beginning with frankly subjective goal statements; 2) a comparison of stated purposes with observation of the program in operation; and 3) increasingly objective evaluation techniques used over increasing spans of time. The evaluation reported here sought to employ the steps outlined by MacLeod and Tyler.

This study poses a question concerning the extent to which one Agricultural Honors Program is achieving its goals. The goals of any educational program are complex, of course, and not all of them are explicit. Thus identifying the full range of goals associated with the program necessitated using a variety of techniques. The goals stated in the college catalog pertain primarily to actions students carry out in the process of completing the program. Some means was needed, then, to pinpoint the less clearly articulated goals of the program.

In 1966-67 the first author interviewed a large number of students and faculty associated with the Honors Program. He also attended several discussions regarding the Program. This procedure resulted in development of a set of expectations for Program outcomes, as seen by its participants. The goals are that a student who has completed the program should:

1) value the scientific method, particularly in its application to the field of agriculture;
2) view agriculture as a profession;
3) have become involved with his academic pursuits;
4) place importance upon intellectual activity;
5) be able to bring knowledge from diverse areas of agriculture to bear on problems in the field;
6) possess the capability of applying scientific methodology to agricultural problems;
7) have established sound relationships with at least a small number of faculty members;
8) be capable of interaction with a range of faculty; and
9) enter graduate school more frequently than his non-Honors counterpart, and particularly a graduate school other than the University of Nebraska.

Some additional goals, agreed to less generally, were identified tentatively for purposes of this investigation. The ancillary objectives specify that the Honors Program should increase: 1) a student's ability to think realistically about his occupational and educational future; 2) the preference for independent work, as opposed to more highly structured and more closely supervised work; and 3) the efficiency and effectiveness of the student's work habits. Of course it seemed desirable also to know how the students felt about the program.

Still further, the area of student-faculty relationship quality was divided into three sub-areas on the basis of the companion study of attitudes in the College as a whole. The three sub-areas involve the extent to which: 1) the relationship resembled an ideal human relationship (patterned after the ideal relationship between a psychotherapist and his client); 2) the advisor was seen as rigid, authoritarian, and distant; and 3) faculty were seen as unavailable and unhelpful.

The degree of accomplishment of two Honors Program objectives could not be assessed in this investigation. The student's ability to think scientifically and to bring knowledge from diverse areas to bear upon problems in agriculture are to be included in future reports, encompassing all the major objectives and using data collected from Honors students (and their non-Honors matched group), who were seniors in 1971, as well as those who were seniors during the present year, 1972. These data should help to answer the question of the extent to which the results reported here will hold up over time and with another group of students.

The objectives in the four preceding paragraphs focus on outcomes of the Program rather than on processes. If no results of student participation can be shown, the events which occur in a student's experience with the Program can have only limited significance.