

Evaluating Minicourses In Undergraduate Biology

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WHEN WE THINK of evaluation, we immediately think of achievement tests. But these are only one form of evaluation. We should also look at entry characteristics of students; specifically, whether they have mastered the necessary prerequisites. If they have not, they may be destined for failure. Student attitudes should also be of concern to teachers. It is possible for the student to learn biology, that is, to achieve, but at the same time learn to *hate* biology! Sometimes instructional materials, such as minicourses, are subjected to evaluation by other teachers. Why not solicit reactions about the materials from students? In these days of accountability, we should not only be concerned about how much our students achieve but also about learning efficiency, or how much learning occurs during each unit of time spent by the student.

In 1970 the Minicourse Development Project was funded by the National Science Foundation in a grant to Purdue University. After successful student tryout of the minicourses at Purdue, it was proposed to NSF that a formal field testing procedure be implemented at 12 selected colleges and universities. The two-year evaluation was funded and began in July of 1972, with the first materials being tested in September of that year. The field testing was coordinated by Don L. Tolliver of the Instructional Media Research Unit at Purdue and myself, under the direction of S. N. Postlethwait.

The purpose of evaluation was to improve the *instructional quality* of the minicourses. In order to do this, the evaluation phase of the Minicourse Development Project examined (i) student achievement; (ii) student entry behavior; (iii) student attitude change; (iv) student reaction to the minicourses; and (v) time needed to master objectives.

Student Achievement

Six minicourses were selected for use in all 12 participating schools to provide a common base for evaluation. Each school selected approximately six additional minicourses to use during each term. Three types of tests were used. Form A consisted of items re-

lated directly to the objectives of the six common minicourses. Form B contained general biology items that were unrelated to the common minicourses. The purpose of the two forms of the pretest was to allow us to determine if the taking of a pretest related to the minicourses had a significant effect on student achievement. Cooperating instructors were requested to randomly split their students into two groups for the pretest administration. The students who took form A of the pretest are hereafter referred to as the experimental group; those who took form B are the control group.

Immediately upon completion of each minicourse, an examination was given covering only the content of that minicourse. At the end of the term, students in both the experimental and the control groups took the posttest. The posttest was, in fact, the same test as form A of the pretest and was given to measure retention of the content of the minicourse over the term.

Student Entry Behavior

It is possible for a student to fail a given minicourse, not because of the instructional quality of that minicourse but because he has not met the necessary prerequisites or entry behavior for that minicourse. To facilitate the evaluation of prerequisites, it is important to have specified these prerequisites in behavioral terms. I recommend a format identical to that used in stating objectives (Russell 1974).

Sometimes it is not necessary to administer a test of entry behavior. Frequently in a series of minicourses, one minicourse will be the prerequisite for a following minicourse. If the student has just passed the posttest for the first minicourse, it is not necessary for him to take an additional, similar test for entry into the second minicourse. On the other hand, if the prerequisite material was covered in a previous course, or at a much earlier time, it is best to ascertain if the student can demonstrate competence at the specified entry level before he begins the minicourse. If he does not meet the requirements, remedial instruction or tutoring should be provided to bring him up to the necessary level of competence. Otherwise, he may be destined to failure regardless of the quality of the minicourse.

Student Attitude Change

Student attitudes toward biology were measured by the "Biology Attitude Scale" which was developed and validated by the Minicourse Development Project staff

(see *ABT* 37[5]:270). The biology attitude scale incorporates both Likert-type and semantic differential items. Likert-type items ask the student to respond to statements about the subject, in this case biology, on a scale from "strongly agree" to "strongly disagree." In responding to a semantic differential instrument, the student rates a given concept, in this case biology, on a series of bipolar adjectives (Russell and Hollander 1975).

An attitude measure may not detect small changes in attitude as the result of a single minicourse. In fact, there may be no significant change in attitude as a result of a single minicourse. However, changes in attitude can be measured over a longer period of time, such as a semester or school year. The biology attitude scale was administered at the beginning and the end of the term in order to measure *changes* in attitude.

Student Reaction to Minicourses

You can ask a few students for their reactions to a minicourse. This is a time-consuming task for both the teacher and the students. In addition, students may be unwilling to be completely honest in the presence of the teacher, particularly if the comments are negative. In order to provide anonymity and at the same time structure the student comments, an open-ended questionnaire can be used. Questions of the following kind can be included:

1. What was the *one* strongest aspect of this minicourse?
2. What was the *one* weakest aspect of this minicourse?
3. Was the experiment on plant growth of value in meeting the objectives?
4. What was your reaction to the film loop on photosynthesis?
5. What changes should be made in the structure of this minicourse?

With a class of 30 students, most of the positive and negative points in the minicourse will be brought out by the first two questions. In addition, you can include specific questions about media and activities you are especially interested in having evaluated.

When eliciting student reactions from a large group of students, it is easier to use a standardized form. We designed a multiple-choice questionnaire which could be computer scored (see fig. 1). Using data from many students about many minicourses, the mean scores of all the items for each of the minicourses were compared to determine which minicourses the students perceived to be weak. In identifying a "weak" minicourse, the student responses to particular items helped determine what portions of that particular minicourse needed to be improved. The minicourse was then revised on the basis of objective information

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MINICOURSE EVALUATION

Evaluator:

Minicourse development is a long and often painstaking process. The minicourse that you have just completed has undergone several modifications and refinements, primarily directed by the constructive criticism of students in the past. As an integral part of our program of minicourse development, YOUR help is needed.

Please read each item carefully and choose the answer (A, B, C, D, or E) that comes *closest* to your feelings on the matter. When you have made your choice, darken in the appropriate bracket for the corresponding item ON THE COMPUTER CARD. DO NOT write on the questionnaire itself. Also, since we are only interested in your FRANK evaluation of the minicourse, please DO NOT write your name on the computer card but please DO be honest in your evaluation. Indicate the title of the minicourse on the TOP of the computer card.

Finally, a separate COMMENT SHEET is provided for any additional comments, criticisms and suggestions you may care to make with respect to the minicourse. Your cooperation is appreciated.

Below are 2 example items. The first item contains a standardized rating scale with 5 anchor points: Strongly Agree (SA); Agree (A); Neither Agree, Nor Disagree (N); Disagree (D); Strongly Disagree (SD).

Example A:

The United States is in need of a National Health Program. (If you neither agree, nor disagree, blacken in column C on the IBM card.)

	SA	A	N	D	SD
	A	B	C	D	E

The second type of item on the questionnaire contains an open ended statement to which you will be required to respond more specifically.

Example B:

Current progress in developing a National Health Program has been

A	B	C	D	E
Too slow		About right		Too Fast

(If your feelings more closely correspond to about right, blacken in column C on the IBM card.)

OBJECTIVES

	SA	A	N	D	SD
1. The objectives were very clearly stated.	A	B	C	D	E
2. The materials presented were related to the objectives.	A	B	C	D	E
3. I feel that the stated objectives for this minicourse were achieved.	A	B	C	D	E

AUDIO

	SA	A	N	D	SD
4. Voice quality was very clear.	A	B	C	D	E
5. Speaker's mood was very enthusiastic.	A	B	C	D	E
6. Instructions were clear and easy to follow.	A	B	C	D	E
7. Instructions for the exercises/activities were adequately explained for my knowledge of the topic.	A	B	C	D	E
8. Pacing	A	B	C	D	E

A	B	C	D	E
Too slow		About right		Too fast

9. Overall evaluation of audio presentation

A	B	C	D	E
Excellent	Good	Average	Below average	Poor

MORE ITEMS ON REVERSE SIDE

STUDY GUIDE AND HANDOUTS

	SA	A	N	D	SD
10. The written material was clearly presented.	A	B	C	D	E
11. The written material was brief and to the point.	A	B	C	D	E
12. The study guide and audio tape were very well synchronized.	A	B	C	D	E

VISUALS (photos, charts and diagrams)

Note: If there were no visuals in this minicourse, leave questions 13-15 blank.

	SA	A	N	D	SD
13. In general, the visuals were of excellent quality (clarity).	A	B	C	D	E
14. The visuals were smoothly presented and integrated within the sequence of the minicourse.	A	B	C	D	E
15. The visuals were <i>effective</i> in contributing to my understanding of the subject matter.	A	B	C	D	E

TANGIBLES (Specimens and models)

Note: If there were no tangibles in this minicourse, leave questions 16-17 blank.

	SA	A	N	D	SD
16. In general, the tangibles were smoothly presented and integrated within the sequence of the minicourse.	A	B	C	D	E
17. The tangibles were <i>effective</i> in contributing to my understanding of the subject matter.	A	B	C	D	E

GENERAL

	SA	A	N	D	SD
18. I found this minicourse very stimulating.	A	B	C	D	E
19. This minicourse was very organized.	A	B	C	D	E
20. This minicourse was relevant to my interests.	A	B	C	D	E

21. I spent approximately _____ on this minicourse

A	B	C	D	E
Less than an hour	1 hour	1 1/2 hours	2 hours	more than 2 hours

Please make any additional comments, criticisms and suggestions relevant to this minicourse on the COMMENT SHEET.

Thanks again for your cooperation!

Fig. 1. Computer-scored questionnaire used for student evaluation of minicourses.

rather than subjective assumptions. The modified minicourses were retested with additional students to ascertain their reactions to the revised minicourse and to check its effectiveness.

Time

Information about the time required to complete a minicourse is very important for scheduling, particularly if there are limited learning center facilities and the student must use the materials and the equipment

there. The time it took students to master the objectives for a particular minicourse varied greatly. Time spent is usually slightly inflated since the students do not devote all of the time in the learning center to studying the minicourse. Some time may be spent socializing with a friend, sharpening pencils, and day-dreaming. And sometimes the students deliberately inflate the time figure to impress the teacher. This factor can be minimized by convincing the students that time spent will not be used in grade determination.

Sample Results

Prior to the field study it was felt that the pretest (used with the posttest to determine achievement) might in fact be a learning experience. If so, it was expected that those students (experimental group) administered form A, which was related to the common minicourses, would have a higher percentage of correct responses on the posttest than those students (control group) administered form B, which contained unrelated items. Sample data from six minicourses is shown in table 1. The results for the field testing period provided few significant differences and those that were significant were scattered across various schools and different minicourses as well as favoring both the experimental and control groups in different situations.

On the basis of the data (only a sample of which is presented in this article), we concluded that the pretest covering the minicourses given at the beginning of the term had *no* significant effect on student achievement for either the posttest administered immediately after completion of the minicourse or the posttest taken at the end of the term.

Several previous studies by other researchers (Hartley 1969; Samuels 1969; Warr et al. 1970) have indicated that pretests have significant effect on student achievement. In the case of this study at least three factors might have negated any possible pretest effects. First, the time range was longer than in these other studies. For this project, the time between the pretest and the posttest at the end of the term was 10-16 weeks. In many of the previous studies, the pretest was given immediately before the study unit which was followed immediately by the posttest. Secondly, our pretest was longer than most other studies'. The minicourse pretest contained 40 items from the six common minicourses, and the items were not identified as to which minicourse they represented. Finally, and perhaps most importantly, we believe that the objectives which accompanied each minicourse served the same function as the pretest in some of the earlier studies by alerting *all* students to the important content in the minicourse which would be covered on the posttest.

Summary

Evaluation is one of the most important aspects in the design, development, and utilization of minicourses. A number of factors should be evaluated: stu-

Table 1. Results of form A pre- and posttest administration to minicourse students in 12 different schools. The control took form B of the pretest, but at the end of the term, both control and experimental groups took the posttest (which was also pretest form A) so that content retention could be measured. Both groups took an examination on the content of each minicourse immediately upon completion.

Minicourse	School	Mean minicourse exam score		Mean posttest score		
		score (exp)	(exp) (con)	(exp)	(con)	
Aseptic Techniques	1	32	90	84	74	76
	2	42	85	83	81	86
Water Pollution	3	34	78	77	56	64
	4	37	79	75	69	67
Endless Quest I	5	33	64	65	59	60
	6	41	68	78*	67	67
Endless Quest II	7	51	85	74*	59	73*
	8	48	90	86	75	78
Unit of Life	9	34	85	84	65	76
	10	34	82	84	67	69
Mitosis	11	19	59*	63	48	38*
	12	24	73	75	44	48

exp = experimental group

con = control group

*difference between experimental and controls groups significant at the .05 level

dent achievement, entry behavior, student attitude, student reaction, and the time needed to master. The time and effort spent designing and using effective evaluation are usually returned many fold by increased student achievement, more positive attitudes toward the course, and greater efficiency in learning.

REFERENCES

- BLOOM, B. S., J. T. HASTINGS, and G. F. MADAUS. 1971. *Handbook on formative and summative evaluation of student learning*. McGraw-Hill Book Co., New York.
- HARTLEY, J. 1969. Observations on the training function of a pretest. *Industrial Training International* 4:134.
- HEDGES, W. D. 1966. *Testing and evaluation for the sciences*. Wadsworth Publishing Co., Belmont, Calif.
- POSTLETHWAIT, S. N., J. NOVAK, and H. T. MURRAY. 1972. *The audio-tutorial approach to learning*. Burgess Publishing Co., Minneapolis.
- RUSSELL, J. D. 1974. *Modular instruction*. Burgess Publishing Co., Minneapolis.
- , and S. HOLLANDER. 1975. A biology attitude scale. *American Biology Teacher* 37(5):270.
- SAMUELS, S. J. 1969. The effect of post-test relevant pre-tests and discussion type feedback on learning and retention. *Psychonomic Science* 16:67.
- WARR, P. B., M. W. BIRD, and N. RACKHAM. 1970. *Evaluation of management training*. Gower Press, London.

Useless Knowledge

Facts are worthless to a man if he has to keep running to somebody else for advice on how to use them.

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