DOCUMENT RESUME

ED 091 210 SE 017 779

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TITLE A Possible Model for Developing Performance Based Inservice Modules that Provide Elementary Teachers with Content Background in Science: An Application of the Model.
PUB DATE 18 Apr 74
NOTE 12p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (47th, Chicago, Illinois, April 1974)

EDRS PRICE MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS *Curriculum Design; *Educational Research; Elementary School Science; Elementary School Teachers; *Inservice Education; *Mechanics (Physics); Models; Science Course Improvement Project; Science Education; *Teacher Education
IDENTIFIERS Research Reports

ABSTRACT

Presented in this report is a discussion of a model for developing modularized and behaviorized inservice materials that meet the needs of individual teachers for improving their background in science and for relating this knowledge directly to their classroom experiences. The model consists of four stages: (1) needs analysis of curriculum for content areas, (2) definition of performance skills needed to master and teach content, (3) design of activities to facilitate mastery of the performance skills, and (4) development of criterion-referenced measures to evaluate, diagnose, and prescribe. The model was applied to the development of an inservice program designed to help elementary school science teachers master the Newtonian Mechanics involved in SAPA materials in levels A through E. The Newtonian Mechanics module was field-tested during the summer of 1972, and data were used for further development and refinement of the module. A pretest-posttest control group design was used in the fall of 1973 with a random sample of 14 college juniors enrolled in an elementary science methods course. A control group (N=14) did not use the module. Data analysis showed that module activities caused learning to take place. (Author/PEB)

A POSSIBLE MODEL FOR DEVELOPING PERFORMANCE BASED INSERVICE MODULES THAT PROVIDE ELEMENTARY TEACHERS WITH CONTENT BACKGROUND IN SCIENCE: AN APPLICATION OF THE MODEL

Paper Presented to
National Association for Research in Science Teaching
Chicago, Illinois * * April 18, 1974

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Support provided in part by
National Science Foundation Grant No. GW6703 to
DEL MOD SYSTEM
in cooperation with
MARSHALLTON-McKEAN SCHOOL DISTRICT

ABSTRACT

This paper discusses a model for developing modularized and behaviorized inservice materials that meet the needs of individual teachers for improving their background in science and relating this knowledge directly to their classroom experiences. It then describes the application of this model to the development and evaluation of a Newtonian Mechanics module for elementary teachers. Successful evaluation of this module infers that the model is viable for developing content centered inservice education activities.

INTRODUCTION

Curriculum coordinators and science supervisors report that adopting and implementing new inquiry oriented elementary science curricula such as SAPA (Science--A Process Approach), SCIS (Science Curriculum Improvement Study) and ESS (Elementary Science Study) in classrooms often proves to be a difficult task. Teachers are often unfamiliar with the science concepts, materials and approaches. They express apprehension about using new materials and approaches they do not understand. The retraining of the established professional may be the most serious obstacle for successful implementation of an inquiry oriented science program in the classroom.

New preservice programs in science education for elementary teachers are producing professionals who possess the tools to implement successfully most modern science programs. A process-centered model for inservice teacher training has been developed to help teachers learn the science process skills needed to teach the SAPA curriculum.[2] This approach has been individualized at the University of Delaware for use with both preservice and inservice teachers.[3]

Deficiencies in teachers science content background may still inhibit the effective implementation of a science curriculum in classrooms. A complement to a process-centered inservice training model is a content-centered approach. The content-centered materials would provide the theme of the program. The inquiry skills would be incorporated into the instructional materials and approaches. Advantages of a performance-based content-centered inservice model over process models include:

1. The content-centered approach gives teachers insight for understanding why the writers established certain goals and how various curriculum materials are interrelated.

2. Relating content to specific materials in SAPA provides each teacher with a small piece of curriculum he can explore in depth and thus gives him the confidence he needs to teach the materials in his own classroom.

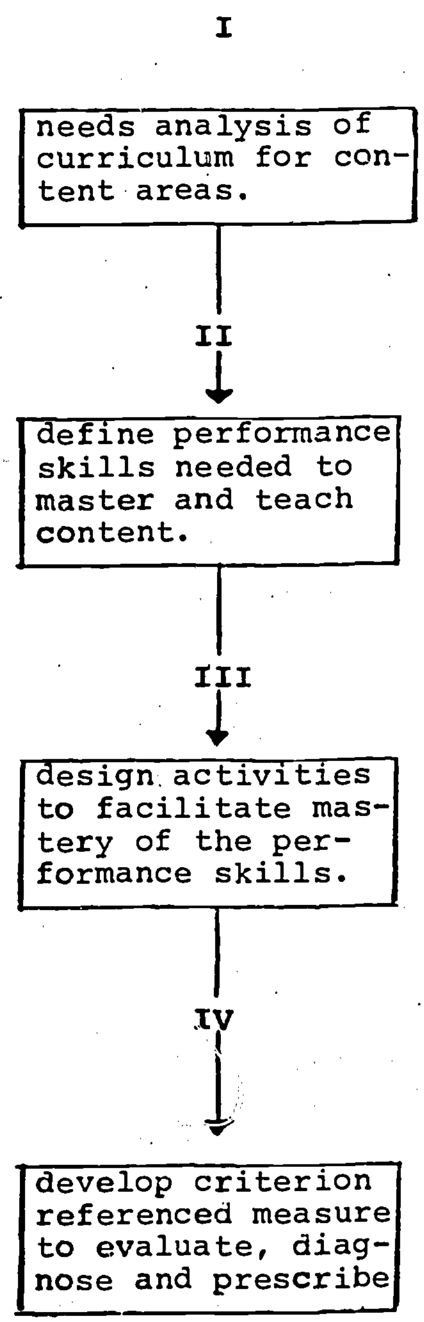
3. Behaviorizing and individualizing the module enables a teacher to begin his study of the module where he feels it is necessary.

4. Content-centered modules can be made small enough for use in two-or three-day workshops while maintaining their logical coherence.

THE MODEL

The model is based on the assumption that to retrain teachers for adopting a new curriculum the materials must be related directly to this new curriculum and must be designed to meet the needs of individuals. Figure I shows the stages of the model.

FIGURE I



Stage I includes an analysis of the curriculum to identify the major content areas found in the science materials. Then, teachers can identify major content areas where they feel their own background is weak. These teacher-identified content areas form the core of the inservice programs.

In Stage II, teacher performance skills are identified for mastery of this content and for teaching children in the mode intended by the curriculum developers. The behaviorization of the content is essential if teachers are to know explicitly what they are expected to master.

Stage III includes activities that facilitate mastery of the performance objectives of Stage II. The activities should be designed to utilize the same instructional methods that teachers are expected to adopt when they teach the new science curriculum in their classrooms; i.e. inquiry method laboratory. The activities should be semi-individualized and keyed specifically to objectives so individual needs of the teachers can be satisfied. The activities should incorporate exercises and equipment similar to which their children will be exposed. This gives the teachers hands-on experience to alleviate apprehension of the new curriculum.

Criterion referenced measures are developed in Stage IV which can be used by teachers or inservice leaders to evaluate mastery of the objectives and diagnose weaknesses enabling teachers to plug into the module where they need instruction. The tests can also be used to evaluate the instruction itself.

APPLICATION OF THE MODEL

MODULE DEVELOPMENT

This model was applied to the development of inservice materials designed to provide the background in physical science necessary to successfully supplement the SAPA program in a school district.

The first step in the development of these learning materials was to examine the SAPA materials in levels A through E. A large number of exercises related to Newtonian Mechanics was found. Exercises included objectives, activities, and materials related to the Newtonian concepts of time, motion (linear and angular), acceleration, mass, force and momentum. Thus, Newtonian Mechanics was chosen as a content area suitable as a theme for an inservice program.

The pupil objectives relating to the Newtonian concepts mentioned above were transformed into objectives applicable to this adult population. From this information, nineteen performance objectives were defined, written and organized into a logical order to facilitate the sequential learning of these skills. Objectives ranged from "measure distance in metric units" through "apply the measurements in the unit of measurement, the Newton."

A set of nine activities was organized and sequenced to facilitate the mastery of these objectives. Each activity was designed to encourage data collection, graphing and interpreting graphical data.

Each activity was keyed to specific objectives. Several activities incorporated SAPA exercises and equipment to give the teacher experience with the SAPA materials. The SAPA part E pan balance and part C and E spring balance activities were among those used in this module. The mathematical level of all activities was below that expected of a high school physics class.

A participant booklet incorporating these activities was produced with laboratory exercises written so the teachers could progress individually through the module. It was <u>not</u> written as an independent learning package, however, as much leader and participant interaction was intentionally built into the laboratory exercises. It was also expected that the laboratory experiences would usually be performed in small groups to generate peer interaction.

Two criterion referenced measures were developed to evaluate mastery of the objectives, to diagnose weaknesses, and to prescribe learning activities. Most items were pencil-paper type, but some items required the learner to use a ruler to demonstrate measuring skills. The limited time allotted for conducting an inservice workshop forced the development of a short test. The first form had fifteen items. Later, two parallel forms were written with eighteen items each.

MODULE EVALUATION

The module was field-tested in the Summer of 1972.[4] A pre-experimental one group pretest-posttest evaluation was conducted because conditions prohibited a true experimental design. Eighty-one per cent of the participants demonstrated 50% gain scores and 50% of the participants demonstrated 100% gain scores. No conclusions can be drawn from these data. However, it was felt that the data and a highly favorable set of comments from the participants warranted further development of the module.

After the workshop was completed, a Leader's Commentary was written and the materials and tests were refined. This revised module was used in a workshop for elementary teachers during the summer of 1973.[5] A second pre-experimental one group pretest-posttest evaluation was conducted. A dependent sample $\underline{t}$ test between the pretest and posttest was significant at the .02 level ($t=2.68$, $df=14$).[6]

A pretest-posttest control group design was conducted on selected module activities in the fall of 1973. A random sample of 14 college juniors enrolled in the elementary science methods course at the University of Delaware were exposed to selected module activities relating to force and motion. The topics of force and motion were chosen because of their relevance to exercises they would be teaching children. The control group consisted of those juniors enrolled in the method's course not chosen for treatment. (N=14).

The module criterion referenced test was refined and expanded to 26 items for use in evaluating the module activities.

Livingston's Coefficient of Internal Consistency, a measure that purports to assess the internal consistency of a criterion referenced test was calculated.[7] This measure is similar to the Kuder-Richardson formula except that it utilizes the mastery-cut-off-score rather than the mean. The mastery level was set at 80%. The measure was evaluated from pretest scores (Livingstons KR-20'=.93)

The treatment and control group means and standard deviations in both the pretest and posttest are reported in Table I. An independent samples $\underline{t}$ test applied to the posttest scores was significant at the .001 level (t=4.26 df=26).[8] The module activities caused learning to take place.

TABLE I

	TREATMENT		CONTROL	
	M	S.D	M	S.D
PRE	14.86	2.64	15.29	2.5
POST	21.42	2.02	17.5	2.66

DISCUSSION

The results of this study imply that this theoretical model can be used for research and development of inservice education modules designed to improve knowledge of science by classroom teachers. A further test of this model could include assessing the effects of teacher knowledge gain on improving children's performance as recommended by Turner.[9]

However, evaluating pupil achievement is not feasible for instructors of inservice materials. Long-range effects should be assessed as part of a total curriculum rather than assessing a single component. For the present, one must be content with evaluating short term effects on workshop participants.

FOOTNOTES

1. Preparation of the module was supported in part by the National Science Foundation Grant No. 6703 to the DEL MOD System in cooperation with the Marshallton McKean School District.

2. Science--A Process Approach, Commentary for Teachers, Xerox, New York, 1970.

3. Uffelman, Robert L. and Knight, Carlton W. Study Guide for Teachers Science A Process Approach, Science Resource Center, College of Education, University of Delaware (unpublished), 1972.

4. This workshop was conducted by Mr. John Reiher, the state science supervisor in Delaware, and the author. It was conducted in the Marshallton McKean School District with 16 teachers and was funded by the DEL MOD System.

5. The workshop was conducted by the author and Mr. Dennis Reilly, a DEL MOD Field Agent and was cooperatively funded by the DEL MOD System and the Marshallton McKean School District.

6. Glass, G.V. and Stanely J.C., Statistical Methods in Education and Psychology. Englewood Cliffs, NJ. Prentice-Hall, Inc., 1970, page 298.

7. Livingston, S.A., "Criterion-referenced applications to classical test theory", Journal of Educational Measurement, 1972. page 9, 13-26.

8. Glass and Stanley, page 295.

9. Turner, R.L. Levels of Criteria The power of Competency-Based Teacher Education: Final Report of the Committee on National Program Priorities in Teacher Education. Washington, D.C. National Center for Educational Research and Development, Office of Education, United States Department of Health, Education and Welfare, July, 1971.