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ABSTRACT

The Competency Based Teacher Education (CBTE) effort in science methods has been responsible for generating a different approach to university-level instruction. Student achievement of specified goals is greater than in the traditional program, and study perceptions of the instructional experience suggest that competency-based instruction emphasizes, more than the traditional approach, such things as independent, activity-oriented, assignments and that such assignments contribute more to success in the course than instructor interactions or assigned readings from text. The successes of the CBTE science methods course do not appear to be translated into differences in behavior during a later directed teaching experience. Overall, Central Michigan University (CMU) students are viewed as successful in lesson planning and lesson teaching in the directed teaching experience, whether they participate in CBTE or non-CBTE sections of the science methods course. The data of the current project suggests that CBTE has effects at the level of the university classroom, but that these effects are not translated into behavioral differences in the classroom. The presence or absence of field experiences concurrent with the CBTE modules does not seem to moderate these results. (Author/BJG)

A CBTE PROGRAM DESIGN

INCORPORATING

COMPARATIVE AND RETENTION DATA FOR EVALUATION

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A CBTE Program Design Incorporating
Comparative and Retention Data for Evaluation

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The literature is replete with research focusing on elementary school science, yet it has been this researcher's observation that teachers in many elementary schools teach very little, if any, science. At best science in the elementary schools is taught incidentally, rather than systematically. Only the introduction of the "kit" approach in the "new" sciences (AAAS, SCIS, ESS, et. al.)[1] has kept elementary school science from virtually being buried among the also-rana (or "frills") in an elementary school curriculum. The "kit" approach, introduced in the early 1960's, has not been universally adopted, although it is widely discussed. Elementary schools all over the United States continue to use out-dated or insufficiently revised publications and practices in science instruction. This important subject ought not to be interpreted by children as 'Science is something that happens when someone brings a capped jar to school'.

While there is some excellent science instruction being offered in elementary schools, it is neither uniform, systematic nor behaviorally based.

The general problem to which the research for this paper is addressed was the development of a competency based college level elementary science education methods experience (or course). Its major theme was cooperation between University faculty members and elementary school teachers. State Minimal Performance Objectives in Elementary Science were utilized in the planning in which competencies were identified and organized in a modular format.

It was hypothesized that a set of competencies for elementary teaching candidates would be generated which would result in (a) greater achievement in the science methods course, (b) more positive attitudes toward the teaching of science as a process, and (c) a more successful student teaching experience. The original multi-phase project encompassed several specific problems which can be grouped into three general classes: (a) the development problem of generating new instructional materials and strategies, (b) the evaluation problem of determining the extent to which materials and strategies had their desired effects. (i.e., retention) and (c) research problems concerned with the comparative effects of different levels of field-experience during pre-service proparation of teachers and with the validity of self-reports of achievement. The project supported

[1] AAAS - Science A Process Approach; SCIS - Science Curriculum Improvement Study; ESS - Elementary School Science

by a grant to Robert G. Oana from the Michigan State Department of Education was done in cooperation with elementary school teachers in Mt. Pleasant, Michigan.

The project plan involved four phases:

(1) Development (Winter '74) - identification of competencies and the creation of modules by a team of University faculty and public school teachers.

(2) Initial Tryout (Winter '74) - implementation of the modules in five sections of the University's science methods course including concurrent field experience I.

(3) Revisions (Spring '74, Summer '74)

(4) Initial Tryout Follow-up Evaluation and Tryout of Revisions (Fall '74) - including field experience II (student teaching).

Competency-based instruction is defined as consisting of teaching and learning activities designed to afford students the opportunity to acquire a set of explicitly stated skills, knowledge and attitudes. It is not content, but rather a set of processes and procedures for an inquiry-oriented approach to teacher preparation. It focuses on examining hypotheses, not on administering prescriptions.

Sandra C. Harris and Jack M. Evans taught 130 undergraduate pre-service students in six sections of a science methods course. The students were randomly divided into CBTE and traditional groups. Three groups of students used competency based materials in their science methods course; CBTE 1 had no conjoint field experience, CBTE 2 observed in elementary schools, and CBTE 3 observed in elementary schools and taught a mini-lesson in an elementary classroom as well. The traditional group's course emphasized the use of lecture, discussion, text and demonstrations.

The competency identification by the project team led by Harris resulted in an overall rationale, seven goal statements and specific objectives for each competency area.

Rationale: A basic assumption of the educational enterprise is that what the individual learns in it will be of use to him in his personal, social, and natural environments, now and in the future. The educational institutions must help students to develop content, skills, attitudes, appreciations, and interests that are transferable to other situations and resistant to forgetting.

The science methods class has been designed as a hands-on activity-oriented program. Stress is placed on methods used to generate, organize and evaluate science content. Science is viewed as a process and not as a body of knowledge to be repeated on examinations.

Competency Areas:

1. Process-Inquiry Skills
2. Questioning Techniques
3. Science Equipment and Materials
4. Teaching Tactics
5. Planning for Teaching
6. Classroom Management
7. Evaluation Techniques

Goals:

1. The student will demonstrate competency in: a) the acquisitions of the process skills and, b) the ability to plan activities for elementary children utilizing each skill.

2. The student will utilize specific questioning techniques.

3. The student will identify and utilize science equipment and curricular materials that can be used to conduct learning activities for elementary children.

4. The student will identify and demonstrate the ability to use selected teaching techniques in conducting learning experiences invovling science skills or concepts.

5. The student will demonstrate the ability to make effective short-range and long-range plans for science teaching.

6. The student will demonstrate selected classroom management skills.

7. The student will demonstrate his ability to utilize the given evaluation techniques.

From the competency areas Harris and Evans developed eight (8) comprehensive modules for the science course including: Teaching Tactics; Process/Inquiry; Planning Module: Short Term Teaching Strategies; Planning Module: Long Term Teaching Strategies; Questioning Tactics; Classroom Management; Materials; and Textbook Review and Evaluation.

Charles F. Eiszler, project evaluator developed evaluation instruments designed to generate and interpret data which could be useful in making summative judgements about goals. Essentially the project evaluation focused on the following questions:

1. Do students in CBTE science methods classes achieve the objectives of a modularized science methods instruction?

2. Are the achievements of CBTE and non-CBTE students in science methods classes different?

3. Do CBTE science methods classes generate more positive attitudes toward teaching Science-as-process than non-CBTE classes?

4. Do non-CBTE science methods classes generate more positive attitudes toward teaching science as a body of knowledge than CBTE classes?

5. What are student perceptions of instructional support in CBTE classes and how are these different than in non-CBTE classes?

6. Are CBTE students more effective in lesson planning and implementation during their Directed Teaching (Field Experience II) than non-CBTE students?

In addition to these questions directly related to Project goals, the design and implementing of tryouts and data collecting allowed for the investigation of two research questions:

1. Do students with concurrent field experiences differ in achievement, attitudes toward teaching science, and perceptions of achievement support than students who do not have such experience?

2. How reliable and valid are self-reported achievement ratings?

To deal with these questions the following instruments were used in the project.

Self-Rated Achievement Forms 1 and 2: These instruments required that students rate their achievement of 20 course goals in form 1 and 25 goals in form 2. Form 1 used a five-point scale: 1) Unsuccessful, 2) Somewhat Successful, 3) Moderately Successful, 4) Highly Successful and 5) Extremely Successful. For form 2 a revised five-point scale was used.

Perceived Achievement Support, Forms 1 and 2: These instruments required that students rate aspects of the course in terms of the extent to which each aspect contributed to their achievement. Forms 1 and 2 represent different approaches to assessing this variable rather than a preliminary and revised instrument:

Form 1: During the Initial Tryout this measure included four variables, each of which was rated in terms of its importance as a contribution to the students' achievement of each of the 20 goal statements. The four variables were printed materials used in the course; interactions with the instructor, interactions with other students; personal effort and individual study. The 20 ratings for each of these variables were made on the following five-point scale:

How much did this contribute to your achievement of this goal?
1. No contribution

How much did this contribute to your achievement of this goal? (Cont'd.)

2. Somewhat a contribution
3. Moderately important contribution
4. Highly important contribution
5. Extremely important contribution

Scores on each of the Achievement Support Variables could range from 20 to 100. Lower-bound reliability estimates based on variable intercorrelations for each variable are listed below:

Achievement Support	
Printed Materials	.68
Instructor interaction	.70
Interactions with other Students	.71
Personal Effort	.78

These reliabilities were considered adequate for testing group differences.

Form 2: In the Revision Tryout students were asked to check those items on a list of 13 "learning activities or aspects of the course" which made "an important or significant contribution" to their accomplishments in the course. The 13 items listed in the instrument are listed below:

1. Having a modular format to provide structure in the course.
2. Having objectives specified and made explicit.
3. Having activity oriented assignments and experiences.
4. Having an opportunity to observe children during a science lesson.
5. Having an opportunity to work with children who visited the class.
6. Using the answer sheets that go with instructional modules.
7. Having assigned readings and texts.
8. Having instructor handouts other than instructional modules.
9. Having formal or lecture type sessions with the instructor.
10. Having informal group meetings with the instructor.
11. Having individual conferences with the instructor.
12. Having opportunities to work with other students and discuss coursework with them.
13. Using the Instructional Materials Center.

Attitudes Toward Self: In the Revision Tryout students were assessed on two aspects of self-concept using the semantic differential technique. Two concepts rated were: "MYSELF AS A TEACHER" and "MYSELF AS A SCIENCE TEACHER." Each concept was rated on 25 sets of polar adjectives. Five of these were selected for their heavy loadings on an "evaluative factor" in previous research. Ratings for each concept were summed over the five scales to yield two attitudes toward self scores.

Performance Ratings: To assess performance during Field Experience II, supervising teachers completed a checklist rating form which evaluated the students' performance in preparing lesson plans and teaching lessons in science. Sixteen performance criteria were identified for lesson planning and 20 for lesson teaching.

Conclusions: Data was collected and analyzed with respect to four major questions: 1) What are the outcomes of competency-based instruction in science at CMU? 2) Do CBTE science students differ from non-CBTE students in achievement, perceptions of achievement support, attitudes and directed teaching performance? 3) Do CBTE students who have concurrent field experiences differ from those who do not in achievement, perceptions of achievement support, attitudes toward teaching science, and performance in directed teaching? 4) What do self-ratings of achievement measure?

1. The validity of self-ratings of achievement as a formative evaluation tool was supported. Students self-ratings of mastery of course related goals identified the same weaknesses in the initial version of the modules that were identified in the subsequent performance ratings during field experience II, i.e., the ability to evaluate pupil achievement and learning. Since self-ratings can be collected more conveniently than other assessment data, the finding of even a moderate degree of validity in this respect is important.

2. The validity of self-ratings of achievement as a summative evaluation tool was supported. Self-ratings of achievement successfully discriminated between CBTE and non-CBTE students. Differences were in the expected direction. When comparing CBTE to non-CBTE one of the thorniest problems is that the programs may have the same general goals but operationalize these goals in terms of quite different instructional objectives. Student ratings of their achievement of more general goal statements relevant to both programs is a way of resolving this problem.

3. CBTE and non-CBTE students have different perceptions of their learning experience. CBTE students see learning as more dependent on a variety of instructor independent activities and personal effort than students in a non-CBTE group. Both groups view the instructor contact and use of printed materials in course as similar in their effects on learning. Student perceptions of the learning experience support the content that CBTE learning is more independent of the instructor and more activity oriented.

4. Using concurrent field experiences with some CBTE students did not seem to add to their achievement in the course or subsequent performance in directed teaching. A slight non significant trend in the attitude data in fact, suggested that concurrent field experiences of a mini teaching nature serve only to confront students with the complexity of teaching in the real world without giving them any sense of their competence to deal with and reduce the complexity to manageable levels. Attitudes toward teaching

science were consistently lower in the CBTE group with actual mini-teaching experience.

5. The amount of emphasis placed on science instruction for children with both CBTE and traditional groups of CMU students during this science methods course seemed to have little or no effect on the amount or kind of science teaching done by these students during their field experience II (student teaching). More importantly is their placement with experienced teachers who enjoy teaching science and who have viable on-going science programs. Many elementary teachers regardless of preparation or experience spend very little time in science education with their children.

Summary

In summary, the CBTE effort in science methods has been responsible for generating a different approach to University level instruction. Student achievement of specified goals is greater than in the traditional program and study perceptions of the instructional experience suggest that competency-based instruction emphasizes, more than the traditional approach, such things as independent, activity-oriented, assignments and that such assignments contribute more to success in the course than instructor interactions or assigned readings from text.

However, the successes of the CBTE science methods course do not appear to be translated into differences in behavior during a later directed teaching experience. Overall CMU students are viewed as successful in lesson planning and lesson teaching in the directed teaching experience whether they participate in CBTE or non-CBTE sections of the science methods course.

The data of the current project suggests that CBTE has effects at the level of the University classroom, but that these effects are not translated into behavioral differences in the classroom. The presence or absence of field experiences concurrent with the CBTE modules does not seem to moderate these results.

Appendix I

Behavioral Objectives

1.01. Using the direction and materials provided, the student will demonstrate the following scientific process skills by successfully completing at least one activity utilizing each skill:

A. Observing: given a variety of objectives, the student will select one from those provided and list ten observations.

B. Classifying: given a box containing a variety of objects, the student will classify the objects by separating them into various groups and labeling them.

C. Measuring: given different lengths of paper, the student will arrange them in a logical order and utilize them in measuring some object.

D. Using space-time relations: given geometric shapes, the student will construct new shapes utilizing two or more of the given shapes.

E. Communicating: given an object such as a sugar cube, seed, salt, etc. the student will describe it by listing observations before interaction takes place, during the interaction and after the interaction.

F. Predicting: using materials and directions provided, the student will make a prediction and compare it with actual results.

G. Inferring: given a variety of sealed boxes, the student will select three and infer the identity of objects concealed in the boxes.

H. Integrated Processes (e.g., defining, operationally, formulating hypothesis, interpreting data, controlling variables, experimenting): the student will select a question from those provided and design and conduct an experiment to answer the selected question.

1.02. The student will plan activities for use with elementary children utilizing each of the process skills.

2.01. The student will select a topic in science and formulate questions at each cognitive level indicated by Sanders.

2.02. The student will identify questions as either background-centered or solution-centered.

3.01. The student will examine the following science programs: ESS, SCIS, and SAPA in terms of scope and sequence and perform at least two activities for each.

3.02. The student will identify and utilize basic science equipment for conducting activities that illustrate major science concepts in at least four of the following areas:

A. Measurement
B. Molecules and heat energy
C. Sound energy
D. Light energy
E. Magnets and their properties
F. The energy of electricity
G. Machines and force
H. The earth's changing surface
I. Air and weather
J. The earth in space
K. Seeds and plants
L. Animal groups
M. Human growth and nutrition

4.01. The student will define and identify the following teaching tactics:
- A. Initiating tactics
- B. Focusing tactics
- C. Extending tactics
- D. Terminating tactics

4.02. The student will select activities and experiments from those suggested and complete the activity as described on an accompanying card.

4.03. The student will incorporate the selected teaching tactics in lesson and unit plans prior to the field experience.

5.01. The student will select a science topic and make a daily lesson plan which includes behavioral objectives, activities to be performed, materials needed and evaluation to be used.

5.02. The student will select a science topic and develop a resource unit that could be used with elementary children.

5.03. The student will examine the state science objectives and write out activities that could be used in helping children to acquire those objectives.

6.01. The student will identify the factors in the physical environment that will influence the child's behavior.

6.02. The student will describe situations in which the following can best serve the objectives of the lesson:
- A. Small group
- B. Large group
- C. Individual conferences
- D. Oral work
- E. Written work

6.03. The student will identify alternative solutions to the following problems of the child:
- A. Accidents
- B. Injury illness
- C. Bathroom problems
- D. Physical handicaps

6.04. The student will identify alternative procedures for:
- A. Routine classroom tasks
- B. Behavioral problems
- C. Interruptions of classroom routines

7.01. The student will identify and describe the following evaluation techniques:
- A. Observation
- B. Discussion
- C. Questionnaires and inventories
- D. Anecdotal records
- E. Charts and check lists
- F. Work samples
- G. Dramatization
- H. Logs and diaries
- I. Open-ended questions
- J. Conferences
- K. Teacher made tests
- L. Standardized tests

7.02. The student will utilize the given evaluation techniques during the field experiences II (small group teaching) portion of the class.

7.03. The student will evaluate the given evaluation techniques.