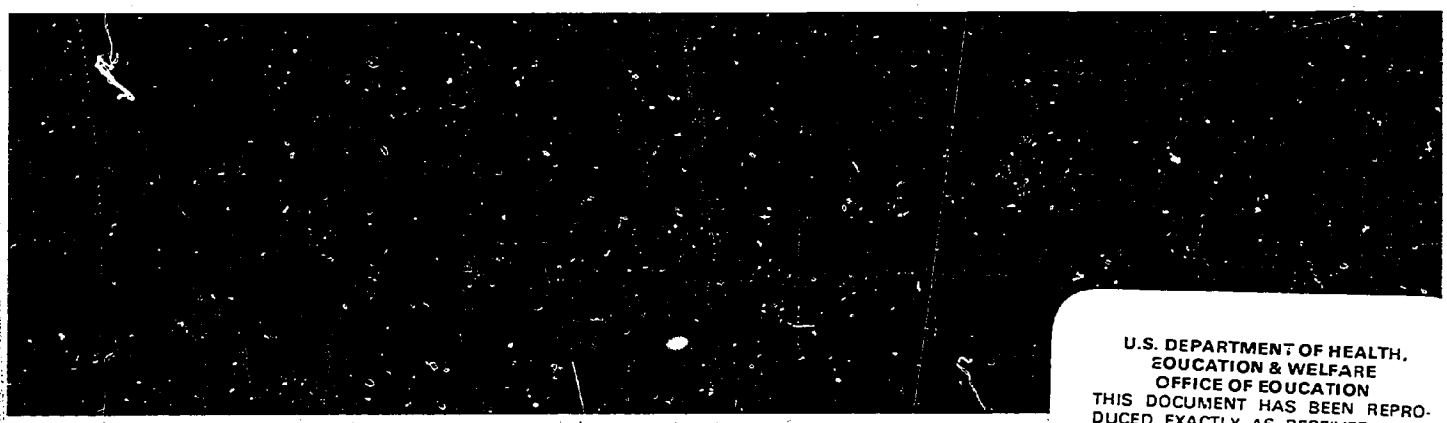
DOCUMENT RESUME

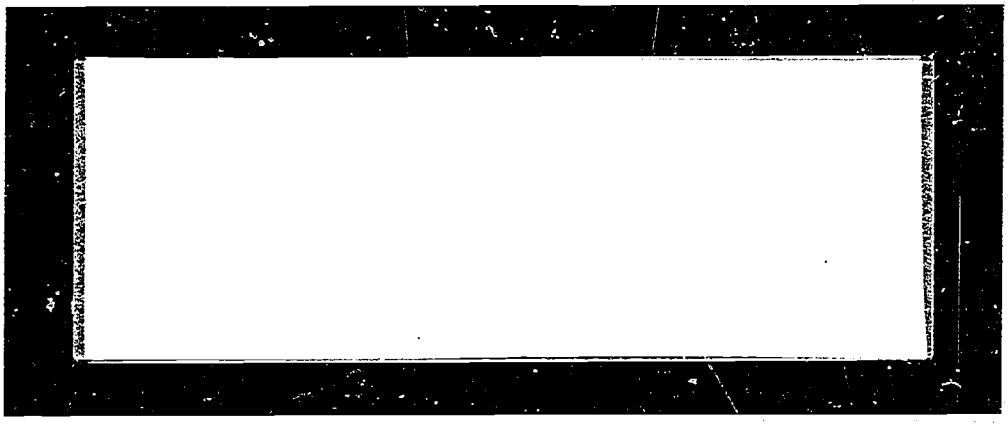
ED 059 917 SE 013 498

TITLE	Promising Practices in Mathematics Teacher Education (Compiled for the Forum on Teacher Education, National Council of Teachers of Mathematics Annual Convention, Chicago, Illinois, April 1972).
INSTITUTION	ERIC Information Analysis Center for Science Education, Columbus, Ohio.
PUB DATE	Apr 72
NOTE	210p.
AVAILABLE FROM	Ohio State University, Center for Science and Mathematics Education, 248 Arps Hall, Columbus, Ohio 43210 ($3.00 plus $.25 handling)
EDRS PRICE	MF-$0.65 HC-$9.87
DESCRIPTORS	College Programs; Curriculum; *Educational Innovation; *Field Experience Programs; *Mathematics Education; *Mathematics Teachers; Methods Courses; *Teacher Education

ABSTRACT

This compilation of 64 papers on innovative programs in mathematics teacher education describes a great variety of current activity, including the use of individualized instruction, flexible grouping, tutorial programs, laboratory methods, new evaluation schemes, micro-teaching, computer assisted instruction, simulation, and field-oriented programs. Two-thirds of the programs concern elementary school teacher education, and are grouped according to emphasis as follows: content, content and methods integration, methodoloty, methodology and field experience integration, and field experiences. The papers on secondary teacher education are grouped under methodology and field experience emphases. (MM)





SMEAC/SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION INFORMATION ANALYSIS CENTER

. . . an information center to organize and disseminate information and materials on science, mathematics, and environmental education to teachers, administrators, supervisors, researchers, and the public. A joint project of The Ohio State University and the Educational Resources Information Center of USOE.

MATHEMATICS EDUCATION REPORTS

PROMISING PRACTICES IN MATHEMATICS TEACHER EDUCATION

COMPILED FOR THE FORUM ON TEACHER EDUCATION
NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
ANNUAL CONVENTION

CHICAGO, ILLINOIS
APRIL 16-20, 1972

ERIC Information Analysis Center for
Science, Mathematics, and Environmental Education
1460 West Lane Avenue
Columbus, Ohio 43221
April, 1972

PREFACE

In May, 1971, the ERIC Information Analysis Center for Science, Mathematics, and Environmental Education sponsored a planning conference which studied ways of disseminating descriptions of innovative programs in mathematics teacher education. Ideas from this conference were adopted by the NCTM Commission on Teacher Education and incorporated into the Commission's planning of a NCTM Forum on Teacher Education.

The Commission Solicited descriptions of promising teacher education programs from leading mathematics educators across the United States and Canada. This compilation is the response to that call. The papers contained here have not been evaluated in any way.

The papers in this compilation are grouped into seven sections. The first five sections contain programs for elementary teacher education. Although divided into discrete sections dealing with content, content and methods integration, methodology, methodology and field experience integration, and field experiences, the papers really represent a continuum of shifting emphases across these general areas. The sections represent an attempt to identify the major thrust of each paper, but in many cases do not completely identify the broad-range concerns of the papers they contain. The reader should use the section divisions only as an initial guide tc the compilation.

These papers indicate that a quiet revolution has been taking place in mathematics teacher education. ERIC/SMEAC is pleased to have been able to provide a leadership role in the dissemination of these program descriptions.

April, 1972

Jon L. Higgins
Associate Director for
Mathematics Education

This publication is sponsored by the Educational Resources Information Center of the United States Office of Education and the Center for Science and Mathematics Education of The Ohio State University, in cooperation with the National Council of Teachers of Mathematics. The publication was prepared pursuant to a contract with the Office of Education, United States Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official Office of Education position or policy.

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SECTION ONE

PROMISING PRACTICES IN MATHEMATICS CONTENT COURSES

ELEMENTARY TEACHER EDUCATION PROGRAMS

The following eight papers describe new program practices where the primary innovations involve required mathematics content courses. Although many of the papers imply close connections between content and teaching methodology, they are primarily concerned with the teaching of mathematics to pre-service teachers.

INDIVIDUALIZING PRE-SERVICE MATHEMATICS EDUCATION

Dr. Clarence J. Dockweiler
Concordia Teachers College

The mathematics content requirement at Concordia has previously been satisfied with one 4-quarter hour course. This obviously falls far short of the recommended hours. The second required course is a combined content-methods course which attempts to pick up some of the loose ends from the first course, as well as, a treatment of methodological considerations.

A change in alignment of course hours now has the content course at six quarter hours and the methods course at two quarter hours. This realignment generated thinking in the department which resulted in the program to be described.

The minimal credit hour requirement does not permit an adequate treatment of all appropriate mathematical topics. Therefore, it was deemed desirable to determine an appropriate entry point for each student. Entering students bring to college a wide variety of mathematical experiences. If levels of proficiency can be determined in "basic" areas, a student may begin study at an appropriate level and be provided study in the "basic" areas and "enrichment" areas as the credit hour restriction permits. ("Basic" areas are presently identified as: Sets and Whole Numbers; Integers, Rationals, and Reals; Numeration; Geometry; and Algebra.) This would permit those with some math proficiencies to progress beyond the "basic" areas and those with minimal preparation to at least study the "basic" areas.

Since Concordia's prime objective is the training of teachers, all entering students (approximately 300 each year) are channeled into this program during their first or second year of college. The students bring a variety of mathematical backgrounds to the program; from one year of general mathematics to the equivalent of five years of mathematics in high school honors programs.

Five faculty members are involved in the development and implementation of the program. Two of the faculty members have recent doctorates in mathematics education. The remaining three are at various stages of completing their dissertations.

- one in science education, studying at the University of Iowa
- one in mathematics, studying at Illinois Institute of Technology
- one in mathematics education, studying at Northwestern University.

Program Resources

I. Time utilization -- The time allocation for a 6 quarter hour course is 300 minutes per week for the duration of the 10-week quarter plus a final examination period. However, a student's

schedule may vary a great deal. In an attempt to provide sections of appropriate levels of study in the basic areas, different types of modules have been developed.

A. For those students requiring a thorough study of the topic, modules of longer duration are available.
B. For those students needing demonstrating a degree of proficiency that still falls short of the desired level, shorter modules are available.
C. For those students demonstrating the desired level of proficiency, no study in that area will be necessary.

A typical quarter's schedule for each of the above-mentioned would be as follows:

A. Students demonstrating very little understanding:	
Sets and Whole Numbers	800 minutes
Integers, Rationals, and Reals	800 minutes
Numeration	400 minutes
Geometry	500 minutes
Algebra	500 minutes
B. Students demonstrating some understanding:	
1. Basic Areas	
Sets and Whole Numbers	800 minutes
Integers, Rationals, and Reals	400 minutes
Numeration	400 minutes
Geometry	250 minutes
Algebra	500 minutes
2. Enrichment Areas	
Probability	400 minutes
Modular Arithmetic	200 minutes
C. Students demonstrating the desired proficiency levels in most basic areas	
1. Basic Areas	
Sets and Whole Numbers	400 minutes
Numeration	400 minutes
2. Enrichment Areas	
Probability	400 minutes
Topology	400 minutes
Modular Arithmetic	200 minutes

II. Money Requirements -- Thus far the program has been developed and taught as part of the normal load of the faculty members involved. The involved staff is assuming somewhat of an overload in order to make the many different modules available. The staff is presently drafting preliminary proposals for funding to more efficiently develop materials and provide a more sophisticated on-going evaluation program.

III. Materials and Facilities -- In addition to existing texts, materials are being developed in order to incorporate individual and small group work into the program. A program is in use in the area of numeration. Laboratory-type activities are in the process

of development and use for geometry and algebra.

Many manipulative materials are available in the Math Education laboratory. Extensive use is made of Cuisenaire rods, geoboards, Dienes block, etc.

Audio tapes on math concepts are available for individual use. Video-tapes are being produced by the staff on several of the basic areas. These are to be used by students independent of classroom work.

The Mathematical Content of the Program

The course content is divided into areas which are either basic or enrichment. If a student does not demonstrate proficiency in the basic areas of the beginning of the course, he will be expected to do so during the course.

I. Basic Areas

1. Sets and Whole Numbers -- The study of sets is limited to concepts, symbols and terminology which are directly related to whole numbers and their operations. The system of whole numbers is therefore developed with a somewhat theoretical base. Operation properties are used to develop understanding of algorithmic procedures.

2. Integers, Rationals, and Real Numbers -- These sets of numbers are presented as extensions of the set of whole numbers to permit the students to develop some grasp of the structure of the mathematics of elementary school. The operations are extended to integers and rationals, whereas, the treatment of real numbers is limited to the numbers and their decimal representation.

3. Numeration -- The topic of numeration deals with the historical development of place-value system. Various historical systems are studied in the light of their contributions to a place-value system. Non-decimal systems are also studied including some work with the operations.

4. Geometry -- Geometric concepts of the elementary school curriculum are studied in an informal, intuitive way. Extensive use is made of physical materials such as a geometric solids and geoboards.

5. Algebra -- The function concept is the most important concept that is studied in this area. Its implications for graphing are considered. Studying pattern to determine the algebraic rule for a functional relationship is also a part of this study. A different look at the traditional topics of factoring and multiplying algebraic expressions is also included.

II. Enrichment areas -- The following are illustrative of the kinds of topics that are being developed. These areas are to be studied by those students that demonstrate some degree of proficiency in the basic areas. All of these areas will be studied at an intuitive, informal level. The intent is to expose the students to concepts and terminology and permit exploration of these topics by means of manipulative materials and a laboratory-type setting.

1. Probability
2. Modular Arithmetic
3. Geometric Constructions
4. Topology
5. Number Theory

Evaluation and/or Research

In the early stages of the program, the staff spent a good deal of time writing behavioral objectives for each of the basic areas and a pre and post-test for each. Data is being gathered on these tests. Since the entry point of each student is critical; considerable care has been and is being extended to develop valid and reliable instruments. Many other researchable questions could logically come from this program, the following are a few:

- comparative studies of this approach with others
- longitudinal studies on understandings, retention, etc.
- independent type of study and class study comparisons
- the effectiveness of laboratory-type activities in developing understandings.

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GROUP COUNSELING TECHNIQUES APPLIED TO CLASSROOM INSTRUCTION

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Pasadena City College

A mathematics course required of all elementary teaching candidates was taught using group counseling techniques during the Spring of 1971 at Pasadena City College. Of the 68 students involved, three were males. Fifteen graduate students from Cal State LA were also taking the course.

On the opening day, students were asked to sit in small groups facing each other and discuss the following questions suggested by Dr. Peters from Glasser's Institute.

(a) A successful learning experience I've had in the past year.

(b) What are some factors which contributed to my learning?

A partial list of the factors was given by the chairman of each group (whom they selected) and put on the overhead projector for general class discussion. A notable omission from these lists was any reference to classroom lectures. Since the members of the group had introduced themselves to each other and were now somewhat acquainted, they were asked to take the same seats for the next few weeks. New groups were formed four times during the semester.

A daily procedure for the semester was a brief (five to ten minute) discussion of the assignment followed by the directions, "Go to groups." Students then turned their chairs around and began working on the lessons together with much animated talking. The teacher's role was to answer questions not readily understood by group members using the Socratic approach and encourage deeper, more exploratory questions from students. In addition to the mathematical manipulation, each lession required the student to formulate a test item based upon the objective of the lesson. Students were encouraged to pose questions along the entire range of Bloom's Taxonomy of Educational Objectives and not limit their questions to the recall level.

Unit tests, the midterm, and the final examination required the student to formulate examples, to state assumptions and their consequences, to analyze, synthesize, and evaluate ideas and concepts. A gang test which the group took together tended to create a cooperative rather than competitive spirit. When the type of test situation was explained, students who had been dreading the activity actually smiled and went to work willingly!

Experiences were designed to illustrate how children working with a mathematical notion for the first time might feel. For example, an amazing system of measurement was introduced using ishs, nings, rhots, and so forth. Using only a conversion table

without any measurement projects, the students were asked to add, multiply and convert from one measure to another in the system. The futility of such exercises was obvious to all, a meaningless dance of the digits!

After the midterm, lunch meetings every Tuesday were held for those who wanted to do additional group work. Four or five students came--usually the same ones. Other students were seen working in groups in the library, cafeteria, and on the PCC grounds.

The aim of introducing the group counseling techniques into the classroom instruction was to bring about a more positive attitude of each student toward mathematics. In so doing, it was expected that the mathematics achievement would not be lessened. This proved to be the case.

Two measures were used to assess the amount of change of attitude: (1) Pre and post scores on the Math Attitude Survey published by Educators Publishing House-MAS 100 A; and (2) comments by the students during the course.

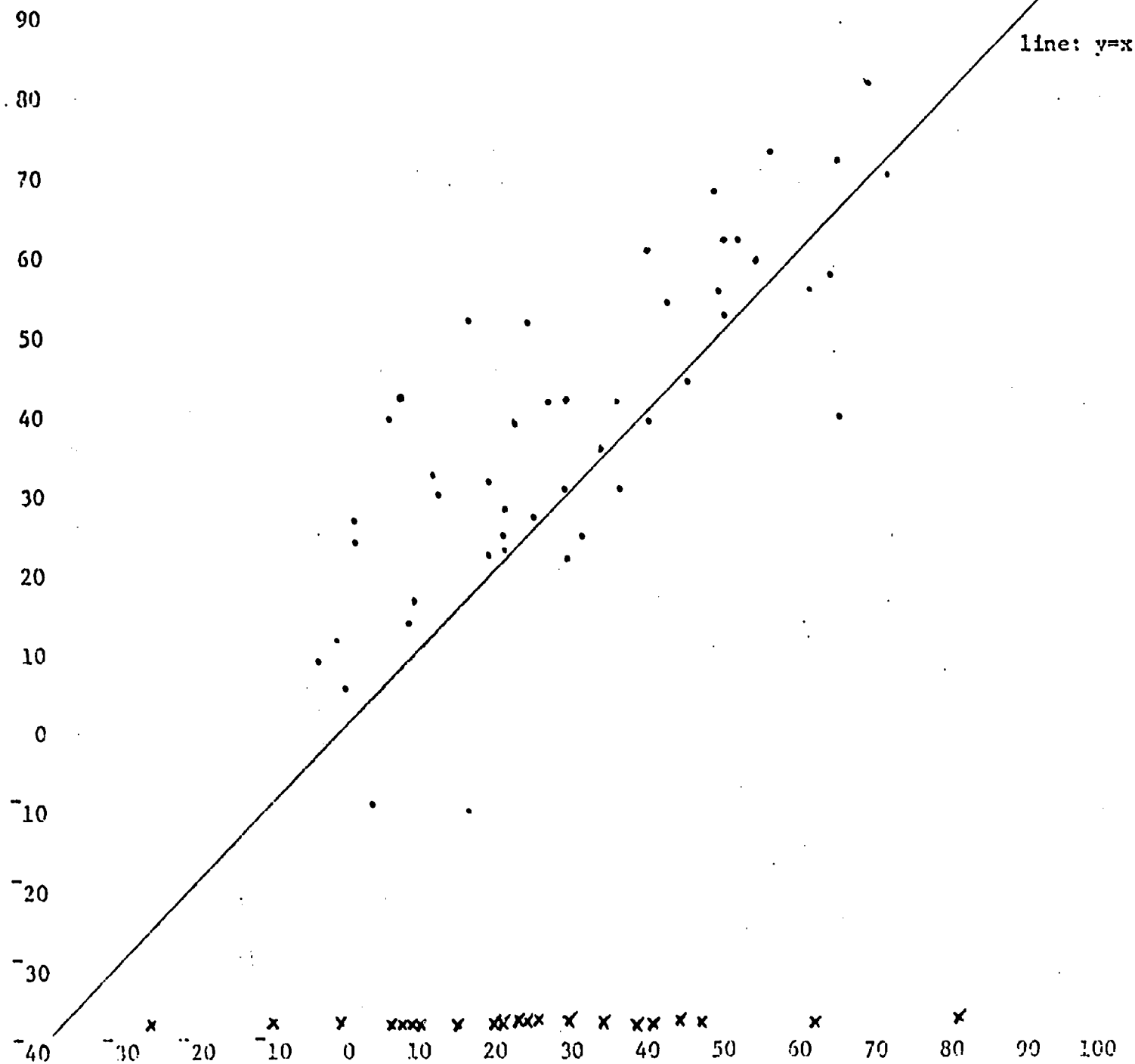
The Math Attitude Survey was given on the first and last days of the semester. The expected range according to the publishers is from +20 to +80. Scores for the 68 students enrolled at the beginning of the term ranged from -26 to 80 with a mean score of 28. The range of the 50 students enrolled at the end of the term was even broader, -28 to +81, with a mean of 37. The lower extreme scores support the commonly observed negative attitude of elementary teachers toward mathematics. The amount of mean increase is highly significant.

The data were also considered by use of the sign test. There were 47 matched pairs of data. Thirty-five showed a positive change while twelve showed a negative change. This result could have occured by chance in less than one percent of the time. The graph shows that the pre and post scores are strongly correlated (.86) which indicates the MathAttitude Survey is consistently measuring something. The wide distribution of the x's* along the horizontal axis shows that the test cannot be used to predict who will drop out.

Each student was shown his score and told that he was above average, in the average range, or below average in his positive feelings toward mathematics. The student was then asked if he felt this was about right. No student disagreed with the results. In one case, a student whose later score was lower than his first score said the the first score was really incorrect because at the time there was a fear of being truthful. Many students readily supplied reasons for their low attitudes, e.g. liking mathematics until being put in an accelerated class, never getting any part credit for the correct part, failing a mathematics class, thinking it was too abstract to be interesting or useful, and so forth.

*Scores of students who only took the pre test.

PRE v. POST SCORES ON MATH ATTITUDE SURVEY _ Pasadena City College, Spring 1971 (Math 38)



During the course, many students stated they preferred this method of teaching because they did not feel so fearful and because they were learning more than they could have by working alone. They said they would tend to use this method when teaching themselves. Only three persons complained about other students not being helpful and asked to be changed out of certain groups. Two people said they would really rather work alone. The learning environment seemed very pleasant and constructive. Students asked better questions after prior discussion with their groups and often were interested far beyond the lesson and followed up on relevant ideas.

Summary and Recommendations

The group method is an excellent technique for teacher training classes. One fact became increasingly obvious. The ways of thinking about a problem are many and varied. Students who, at first, asked about "the best way" of presenting an idea or skill soon observed the need for alternative approaches if the expectation were that all would learn. Preservice teachers listened to well-stated as well as illogical arguments and were free to respond on an equal basis--sometimes resorting to decibel! The need for feedback, communication skills, use of examples and illustrations was seen and quickly met.

The relation of the teacher to each student was more like that of a consultant. Students freely questioned authority, were more curious and searching, became more open-minded, developed a feeling of confidence in their approaches to problems and showed more positive motivation. The classroom atmosphere was friendly, cooperative, and animated.

The positive results with this experimental group indicate it should be replicated with carefully stated instructional objectives and a control group tuaght in the traditional lecture-individual work method. Evidence shows the Math Attitude Survey is both reliable and valid as well as appripriate for this student population. Evidence might also be gathered about this technique and various levels of thinking. It seems probable that peer group interaction could focus and organize learning of certain concepts more efficiently than individual study.

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A DISCOVERY ORIENTED PROBLEM SOLVING APPROACH TO ARITHMETIC FOR PROSPECTIVE ELEMENTARY SCHOOL TEACHERS

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The modern algebraic approach to arithmetic justifies the standard algorithms through binary operations, number facts, and properties of operations. The approach is not a completely successful method of preparing teachers because the content, as a consequence of the abstract approach, fails to deal adequately with the central issue of problem solving.

As part of the TTT Project in Elementary School Science and Mathematics at New York University approximately 50 prospective teachers (in two sections) are spending a portion of the Spring, 1972 semester focusing on arithmetic as the discovery of efficient methods of solving problems that ask the question "How many?" With materials viewed as guiding that discovery the prospective teachers are presented with a conceptually whole model with a clearly defined role for both materials and discovery. A description of the staff, resources, and other structural features involved has been submitted separately.[1]

The ability to conceptualize the collection that is to be counted is the basis of the ability to solve the problems of arithmetic. The child requires ample exposure to such problems and guidance toward the appropriate counting. Furthermore, it is reasonable to expect that with suitable materials and freedom to count, children may not only be guided toward the standard algorithms but will also discover efficiencies of their own. Thus for example, adequate involvement with the distributing and counting inherent in partitioning problems may well lead to the discovery that it is efficient to solve such problems by skip counting.

In order to clearly distinguish for the prospective teachers between the necessary basic counting concepts and the variety of efficiencies they have available, they are first introduced to "a new system of counting to be used throughout the course" (actually, simply base 6 numbers and numerals) and encouraged to solve the problems that arise in the only way that might be

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[1] Professor Stanley F. Taback, A Description of a Model for the Pre-Service Training of Teachers in Elementary School Mathematics.

expected to be available to them--that is, counting. What follows for the prospective teachers is largely an attempt to make them efficient at problem solving (with base 6 notation) using materials and methods similar to those subsequently suggested for use with elementary school children. In particular, meeting in ten weekly three hour sessions, a given meeting is typically devoted to:

a) full group discussion of one or more types of conceptually distinct (in terms of the counting required) story problems;
b) individual discovery of efficiencies through the use of activity cards and manipulative materials;
c) full group discussion of activities and materials in many cases similar to those above, but designed specifically for children.

The individual discovery segment is greatly assisted by the participation in each section of the course of two graduate students, each supported by the project.

Beyond encouraging understanding of the algorithms and skill in their use, it is especially hoped that the sessions described above will enable the prospective teachers to develop in their classrooms a problem solving approach to the study of arithmetic which relies on discovery and the use of suitably structured materials. Their training experiences should give them some sense of the difficulties and triumphs that their students will experience.

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FLEXIBLE GROUPING AND DIFFERENTIATED INSTRUCTION BASED ON ACHIEVEMENT OF BEHAVIORAL OBJECTIVES IN A MATHEMATICS COURSE FOR PROSPECTIVE ELEMENTARY TEACHERS

Ralph B. McBride
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One of the major problems facing a college instructor in the mathematics content course for prospective elementary school teachers is that of coping with the wide diversity evident in both background and ability of those enrolled. Linked with this are the attitudes of his students toward mathematics and toward their future roles in the teaching of mathematics in the elementary school.

In an attempt to find at least a partial answer to this problem the author investigated the classroom management plan described below. Incorporated in this plan were the following modifications: 1) classroom use of behavioral objectives covering the material taught in the course, 2) flexible sub-grouping during each of five units for subsequent study based upon initial testing which assessed achievement of those objectives, 3) a grading scheme which utilized the results of tests given both before and after the sub-group instruction.

Prior to beginning each of the five units behavioral objectives were distributed. After five or six days of large group instruction hereafter referred to as Phase I the class was partitioned into three sections based upon achievement of the objectives.

Two or three days of differentiated instruction was then provided as follows: Basic group - a reconsideration of only that material deemed necessary for a sequential development of the course; Intermediate group - reteaching of those topics involving objectives unattained by this group and the introduction of some optional material; Enrichment group - development of enrichment topics which generally continued the main theme of the unit under consideration but at a higher and usually more abstract level.

Following this second phase the students assigned to the Basic or Intermediate groups were retested on the original objectives. Students assigned to the Enrichment group had already evidenced near mastery of the regular objectives and hence were evaluated by a test covering the enrichment objectives. Grades for the unit were determined by wieghting this second test three times the first. Some provision was made to allow those Intermediate students who were near the top of their group to study the enrichment material as well as reconsidering the regular objectives and then to take both the second test for the unit

and the enrichment test. This gave them a further opportunity to try for an A since only those students who had achieved both the regular and enrichment objectives were eligible to receive an A for the unit.

At the next regularly scheduled class meeting, all of the students enrolled met as one large group to begin the next unit where the above procedure was repeated. This allowed for flexibility in small group membership.

The experiment was conducted during the fall term, 1969, with eighty-eight students enrolled in "Mathematics for Elementary School Teachers" at Manchester College, Indiana. [The study was repeated the following year with results similar to those reported below and again this past fall with some modifications as reported at the end of this paper.] Achievement was compared with that of a representative elementary education population studied by M. C. Withnell in 1967. Other pre- and post-tested variables were test anxiety and attitudes toward mathematics and mathematics teaching. Student reactions regarding the classroom management plan were solicited and analyzed.

Findings

1. Flexible grouping was necessary as evidenced by significant changes in group membership ($p < .001$). A multiple regression equation using six predictor variables including ability, mathematical achievement, attitudes, and test anxiety accounted for 50% of the variance and could have predicted <u>average</u> group membership ($p < .01$).

2. Average group size and achievement of objectives, respectively, were: Basic--28% and 74%; Intermediate--55% and 86%; Enrichment--17% and 94% (also achieved 85% of the enrichment objectives).

3. There was no significant correlation between ability and mathematical growth, and no significant differences in the three pairwise comparisons of growth at three ability levels.

4. The experimental group:
   a) showed significant gains in achievement ($p < .001$),
   b) evidenced reduction in test anxiety ($p < .001$),
   c) displayed a positive, but not significant, gain in attitude toward mathematics.
   d) evidenced no change in attitude toward mathematics teaching,
   e) scored significantly higher on a test of mathematics achievement and a subtest of basic concepts, relative to elementary school teaching, than did the population studied by Withnell ($p < .001$).

5. Student reactions to the classroom management plan and to its components were extremely favorable with 47 students summarizing their attitudes as highly favorable and the remaining 41 indicating favorable reactions.

Conclusions

1. The classroom management plan met most claims made for it. The behavioral objectives provided a means of adequately communicating what was to be learned and contributed to more effective evaluation. The flexible grouping facilitated differentiated instruction, making it possible for students to gain in achievement, regardless of ability.

2. The strongly favorable student reactions to the "two-test" form of grading indicates that this procedure should receive more consideration in mathematics teaching and evaluation.

3. Instruction was least effective in the small-group Intermediate section. Further modification and subsequent investigation is suggested. [see below]

4. The preparation of materials was time-consuming, compensated somewhat in overall time by the large-group meetings during the first phase of each unit.

During the fall term, 1971 two modifications seemed effective in improving the management plan:

1. The intermediate group classes were eliminated during Phase II with opportunity for these students to attend either the basic group classes, the enrichment group classes, or study on their own using the objectives and initial unit tests as guides.

2. The test given to students who had studied the enrichment materials was composed of questions reflecting both regular and enrichment materials. Any student who wished to do so was permitted to attend the enrichment sessions and, at his discretion, take the enrichment test. All others took the test based on regular objectives.

These procedures gave more individual choice to the student, required the enrichment group to review the basic objectives, and provided for a student who previously would have been assigned to the intermediate group the opportunity to attend the enrichment group and still take only one test at the end of the unit instead of two in case he wished to try for an A.

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A RESTRUCTURED CONTENT COURSE IN MATHEMATICS FOR PRESERVICE ELEMENTARY TEACHERS

Jack M. Robertson
Washington State University

Only one three semester hour mathematics content course is required of preservice elementary teachers at Washington State University. This course has traditionally been taught in classes ranging from 60 to 120 in enrollment. Typically, the backgrounds of these students range from that of the student who is prepared for a calculus course to those with limited abilities who have had no mathematics for two or more years and who have very negative attitudes towards mathematics. The diversity of student abilities is probably greater in this course than any other taught in this department. Failure rates have been a problem also. The traditional lecture course in large classes has proven unrealistic for this course.

Recognizing and dealing with the widely divergent backgrounds of students seemed essential. To accomplish this the course would have to be totally restructured and with this ultimate goal in mind an experimental audio-tutorial approach was used in the fall semester of 1971. Under this program 23 students who scored high on the first quiz given in each of three classes (with total enrollment of 164) were invited to take an individualized audio-tutorial course. These students listened to brief audio-tape previews of material to be covered, studied the material and worked problems at their own pace with aid from personnel on duty in the learning laboratory. Lecture time per book section for these students was reduced from approximately two hours to 15 minutes. Also, a part of the experiment was repeatable testing and longer video-tape presentations on certain material. Students could take examinations as they were ready. Thirteen of these twenty-three students completed the course with an A grade (one finishing in five weeks) while the remaining ten all received B grades. This seemed a satisfactory performance overall as the first quiz was given very early in the semester and the selection did not isolate the best students in all cases. Statistical evaluations will be a later part of the course realignment.

Future plans are more ambitious. Under a grant from state monies the audio-tutorial approach will be offered to all students in the course in the fall of 1972. Necessary materials will be prepared under the grant during the coming summer. This will involve interested staff members and selected teaching assistants.

The present learning laboratory consisting of six carrells will be expanded to 24, each equipped with audio capabilities while

nine will have video receivers. Supplementary materials prepared this summer will need to be more extensive than they were for the better students. These will include audio and video tapes, written supplementary materials, computer generated testing, expanded consulting hours and possibly brief seminars and presentations on certain materials.

Plans call for continuing an experimental program in the spring of 1972 to include some slower students. The experience with these students will provide a basis for the preparation of materials for the fall.

It is hoped these procedures are directed at the root problem of the course. Students will be given more individual attention. The three hours of lecture per week is to be replaced by an almost full time learning laboratory with consultants available there. From the experience of the fall of 1971 it also seems likely that the better students will have more incentive to take the optional (but recommended) second three semester hour content course. It is the plan to allow students to continue into the second course as the first is completed. Experience shows that many can make substantial progress on or even complete both courses in one semester. The program will be designed to allow students to complete unfinished portions of the course during the following semester.

Enrollments in the course during the last four semesters were 222 (spring, 1970), 235 (fall, 1970), 223 (spring, 1971) and 164 (fall, 1971).

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PARTNER LEARNING

Clarence Smith
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Purpose: To determine the effect of Partner Learning on Students' mathematical attitude and achievement.

Rationale: Partner Learning has the potential to significantly modify mathematics instruction in college and the public schools.

Partner Learning can be implemented by many instructors with a minimum of expense, time and revision

Program Setting: College Mathematics classes at New Mexico State University and the University of Texas at El Paso

Partner Learning Classes	Compared To:	Control Classes
Mathematics 111 1st Semester Mathematics for Elementary School Teachers	< >	Mathematics 111 1st Semester Mathematics for Elementary School Teachers
Mathematics 112 2nd Semester Mathematics for Elementary School Teachers	< >	Mathematics 112 2nd Semester Mathematics for Elementary School Teachers
Mathematics 459 Geometry for Elementary School Teachers	< >	Mathematics 459 Geometry for Elementary School Teachers
Mathematics 3101 Introductory Mathematics for Liberal Arts Students	< >	Mathematics 3101 Introductory Mathematics for Liberal Arts Students

Trainees: Range of class size: 9-118
Range student classification: College Freshmen - College Seniors

Staff: Design: Doctoral Student, Education Professors and Mathematics Professors
Conduction: Doctoral Student, Mathematics Professors and Education Professors.

Resources: Partner Learning requires one class meeting for a pretest in the classroom and a few minutes to pair the students. The cost for implementing Partner Learning is 28¢, or the cost of a perfect pretest.

The research has been conducted for 1 1/2 years.

Partner Learning is a teaching method which utilizes pairing students in the classroom. Many variations of Partner Learning can be used. The purpose of this paper is to lay a foundation for the method of Partner Learning that was used for this experiment. It is hoped you will discover that Partner Learning can improve the education effort where the lecture method is the primary method of instruction used by the teacher. Partner Learning can be implemented with a minimum amount of expense, time and change.

Students are assigned partners based on their scores on a pretest. The student with the highest score is paired with the student with the lowest score, 2nd highest with 2nd lowest, etc. It must be emphasized to the students that their score is not a representation of their intelligence, but it is a representation of their mathematical background.

After students have been assigned partners, the teacher should explain to the students that they should work with their partners at any time they feel it would be an advantage to their learning math. Each class session should be started by allowing students time to discuss with their partners anything about their math that they do not understand.

The teacher can continue with his own preferred method of instruction for the remainder of the class meeting, with only two major changes:

1. The students should be allowed to discuss their math with their partner at any time they think it will be an advantage to their learning the material being presented.
2. Whenever the teacher thinks it is an advantage, he should allow the students some time in class to work a problem with their partners, to discover if they understand the material being presented.

In order to collect information about Partner Learning, it was necessary to do the following things:

1. Administer a content pretest and posttest.
2. Administer a mathematical attitude pretest and posttest.
3. Administer a Partner Learning evaluation form.

RESULTS OF CONTENT SCORES:

		Instructor	Pretest Mean	Posttest Mean	Gain
Mathematics 111:					
Partner Learning	(N=68)	Langlois	59.04%	90.55%	+31.51%
Control	(N=53)	Langlois	68.38%	89.63%	+21.25%
			PL Gain (minus)	Control Gain =	+10.26%
Mathematics 112:					
Partner Learning	(N=86)	Smith	49.52%	82.61%	+33.09%
Control	(N-47)	Smith	50.51%	80.43%	+29.92%
			PL Gain (minus)	Control Gain =	+ 3.17%
Mathematics 459:					
Partner Learning	(N=19)	Krueger	61.05%	68.70%	+ 7.65
Control	(N= 9)	Krueger	51.65%	54.45%	+ 2.80%
			PL Gain (minus)	Control Gain =	+ 4.85%
Mathematics 3101:					
Partner Learning	(N=118)	Hall	29.38%	65.67%	+36.29%
Control	(N= 74)	Hall	32.62%	60.82%	+28.20%
			PL Gain (minus)	Control Gain =	+ 8.09%

Results of Partner Learning Evaluation Question:
"If you were given the choice, would you choose Partner Learning rather than the usual situation?"

	Yes	No
Mathematics 111	55	11
Mathematics 112	70	7
Mathematics 459	12	6
Mathematics 3101	106	8
	243	32
or		
	88%	12%

Conclusions:

Data has not been statistically analyzed at this time.

For 3 completed classes, the Partner Learning class had a lower mean score on the pretest and a higher mean score on the posttest than the control class. All PL classes had higher posttest means and more gain than control classes.

The students who were in the Partner Learning classes indicated a definite preference for Partner Learning.

It may be that most instructors will find Partner Learning will complement their teaching style. This will help us to achieve our primary goal which is to help the students understand and enjoy mathematics.

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A MATHEMATICS MAJOR FOR ELEMENTARY SCHOOL TEACHERS

Jane O. Swafford
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The Department of Education at Northern Michigan University has long required all students in the curriculum for elementary school teachers to complete an academic major and minor in addition to their professional education courses. Since 1966 the Department of Mathematics has offered a major in mathematics specifically designed for the prospective elementary school teacher. This 30-hour major is offered in addition to the usual undergraduate mathematics major and secondary teaching major.

Eight courses have been designed, beginning at the freshman level with a sequence of two 3-hour courses which are required for all students in the elementary education curriculum regardless of their academic major. These two courses are equivalent to the CUPM Level I real numbers course with the inclusion of some informat metric and non-metric geometry. In order to receive a passing grade in the first of these courses, a student must pass an arithmetic computation proficiency test. Currently, a standardized achievement test is given and a score at or above the 90 percentile for the sixth grade is required. In addition to these two content courses, all students in the elementary education curriculum are required to take a 2-hour methods course in the teaching of elementary school mathematics after obtaining admission to teacher education.

At the sophomore level an additional two-course sequence is offered. These consist of a semirigorous study of sets, relations, functions, graphing, and synthetic division together with a study of statement and predicate calculus with an introduction to groups, rings, and fields. At the junior level an intuitive introduction to calculus is offered in addition to a course in selected mathematical topics for elementary school teacher. The latter includes appropriate topics from number theory, probability and statistics, topology, and the history of mathematics. A reading course in elementary school mathematics education is available at the senior level. In this course past and present research, textbook series, experimental programs, and the professional literature are reviewed. This course also involves some teaching experiences which vary from tutoring one child, to working as a teacher's aid, to teaching a short unit or small group of children in a local school. The major also allows for

one elective. As with all courses taught in the Mathematics Department, prerequisites must be satisfied with a grade of "C" or better.

With faculty advisement, students may substitute other courses offered in the Mathematics Department for the specific courses designed for elementary teachers. However, the senior reading course and the real numbers, geometry, and methods sequence are required for all majors in mathematics for elementary teachers. But provision can be made to exempt the two beginning content courses through examination.

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AN INDIVIDUALIZED, ACHIEVEMENT-BASED PROGRAM FOR A FIRST COURSE IN MATHEMATICS FOR ELEMENTARY TEACHERS

William L. Swart
James K. Bidwell
Nikoline Bye
Central Michigan University

Mechanics of the class:

1. The student studies specified behavioral objectives, and is tested, unit by unit, as he is ready. Measurement, English and metric, is taught through a series of laboratory activities.

2. The student gets instruction and assistance from: (a) teacher, who works with individuals and small groups, (b) preparatory exercises that have been written in response to frequently-asked questions, (c) a collection of books, (d) each other.

Premises on which the program is based:

I. The content that a teacher is expected to teach should be mastered -- as nearly as that ideal can be realized -- and the "curve" grading system does not result in adequate competence, particularly for the C and D student.

   Tests are item-analyzed, a re-study "prescription" is given, and the student is retested until he satisfies the instructor that he has achieved all objectives. No D grades are given.

II. If we want all elementary teachers to master certain concepts and skills that they are expected to teach, we must allow for different rates of learning and variation in background.

   Students may finish the "one semester" course in less than a semester, or may take an incomplete and finish in two semesters.

III. We stand a better change of causing teachers to teach a concept or procedure if we teach it to him in the same form as we expect him to teach it to children.

   For instance, the program does not embed the multiplicative inverse, multiplicative identity, and distributivity in a general treatment of field properties -- with casual reference to application in elementary school. Rather, the student is required to perform as the elementary child is expected to perform.

IV. The teacher tends to teach as he is taught.

Features of the program that are based on this premise:

1. The individualized feature.
2. The form of mathematical content, as discussed above (III).
3. Measurement is taught through activity cards. Each student must measure, pour, weight, and construct.

Current Status

The system is in its third year of development. Six or seven sections per semester are taught under this system.

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SECTION TWO

INTEGRATION OF MATHEMATICS CONTENT AND TEACHING METHODOLOGY

ELEMENTARY TEACHER EDUCATION PROGRAMS

The following ten papers describe programs which attempt to unify the learning of mathematics with the learning of methods for teaching mathematics. Some of these programs also include brief elementary school experiences for prospective teachers.

THE TEACHER EDUCATION PRESERVICE PROGRAM IN MATHEMATICS

I. K. Burbank, E. B. Horne
W. W. Liedtke, J. H. Vance
University of Victoria

I. Elementary Program

The B.Ed. degree is awarded following successful completion of a five year program. At present, certification for teaching is granted following successful completion of the third year of the program. In this "Professional Year," * students take methods courses and do their student teaching. A student who has obtained another degree may be accepted into a one year "Diploma" program to take his professional training.

Content -- All students entering the Professional Year or Diploma program must have completed an acceptable full-year (2 semester) mathematics course at the university level. Mathematics 160, "Fundamental Aspects of Mathematics for the Elementary Teacher," is offered by the Department of Mathematics for students wishing to meet this requirement. The course is taught jointly by faculty in the Mathematics Education Section and by interested members of the Mathematics Department. The syllabus includes: Sets, Logic, Development of the Real Number System, Systems of Numeration, Geometry, Probability, Function and Graphs, and the History of Mathematics.

Students electing mathematics as one of their two teaching areas must complete four semesters of mathematics (other than Mathematics 160) prior to taking their professional training, and a minimum of eight semesters before graduation.

Methods and Student Teaching -- During the Professional Year all students take Education 744, a one semester course in curriculum and instruction in elementary mathematics. Students choose a section of the course which emphasizes the mathematics program either in the Primary (K-3) or Intermediate (4-7) grades.

Education 744 is taught in a classroom-mathematics laboratory area which allows the use of instructional methods and approaches simulating various desired classroom practices. Students attend lectures, perform laboratory activities, play mathematical games, work with instructional aids, construct manipulative materials for pupils, and examine recent books, journals, supplementary materials, etc., to complete class assignments and to prepare lessons for practice teaching.

* 1971-72 enrollment -- 25.

There are presently two patterns of student teaching. In the 3-3-3 program, three weeks of student teaching are completed in October, in February and in May. Thus at least one round of student teaching precedes completion of Education 744 and at least one round is done following the course. In the 2-10 program, which was introduced in 1971-72 on an experimental basis, students go into the schools for two weeks in September for orientation and for placement in classrooms. The next eighteen school weeks are spent on course work at the university, with each student returning to his assigned class a half day each week for observation and practical experience. The student then completes a ten week practicum in that class. Both patterns of student teaching are designed to enable the students to relate the methods courses to actual teaching situations.

In addition to completing Education 744, mathematics area majors take two senior one-semester methods courses in mathematics education before graduation. These courses are usually offered in the summer session for the benefit of practicing teachers.

II. Secondary Program

The University of Victoria provides two routes to certification as a teacher of secondary school mathematics. The first, and usual, route is a B.A. or B.Sc. degree, followed by a professional year. The second route is a five-year B.Ed. program. The only extra ingredient in the latter program is school experience in years three and four. However, the faculty of Education would prefer that students enroll in the B.Ed. program because it is then in a position to offer advice on the selection of courses.

Content -- Education students planning to become teachers of secondary mathematics take between 30 and 48 semester hours of mathematics. A standard program of 36 hours would include:

Calculus	12 hours
Algebra and Geometry	3 hours
Linear Algebra	3 hours
Modern Algebra	6 hours
Number Theory	3 hours
Geometry	3 hours
Computer Science	6 hours

Methods and Student Teaching -- In the Professional Year *, both routes, students do nine weeks of student teaching in three equal blocks. Normally, the first block is done in a senior secondary school, the second in a junior secondary school, and the final block is left as the student's choice. Integrated with the student teaching are 40 hours of instruction in methods in secondary mathematics (Education 761). This course is taught in the instructional area previously described for the elementary methods course.

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* 1971-72 enrollment -- 25

ELEMENTARY MATHEMATICS TEACHER EDUCATION PROJECT

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and
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Federal City College

The purpose of the Elementary Mathematics Teacher Education Project is to develop a "competency based" training program in mathematics for inservice and preservice elementary teachers.

The program is "competency based" in that specific statements of the competencies needed by elementary school teachers for the teaching of mathematics are formulated. These statements form the basis, and are the objectives, of the instructional materials which are developed and implemented.

This approach to inservice and preservice training is being developed in response to three influences: 1) The Georgia Educational Model for the training of elementary school teachers, a college wide program, presumes competency based modules (units) in the subject matter areas; 2) the Atlanta School System is implementing a program based on statements of minimum competencies and conducting inservice programs to assist teachers in attaining these competencies; 3) last and most importantly, many inservice and preservice teachers have been found to lack even rudimentary understanding of the content they teach and of methods by which to teach it. Understanding of the content of elementary school arithmetic is not a necessary consequence of a traditional course in "Mathematics for Elementary School Teacher." Many teachers come to such a course without comprehension of elementary arithmetic, pass the course, and leave it still without such comprehension. The same general comment can be made regarding methods courses, which tend to be of less repute, if possible, than mathematics courses.

The project staff is at present, and will be in the near future, formulating statements of minimum competencies and developing instructional materials for attaining these minimum competencies. The project staff is aware of the need for subject matter understandings which are above the minimum level but considers that meeting minimum standards is of first priority. There are two areas in which minimum competency statements are being formulated: Elementary mathematics content and methods of teaching elementary mathematics.

The hard product of the program consists of a series of

"modules" or units each devoted to some specific area of elementary mathematics content or to some methodological problem. These modules are all designed to have certain features in common:

1. Each module is based on a specific set of minimum competencies which the inservice or preservice teacher must attain in order to complete the module. These are the competencies deemed to be necessary (but certainly not sufficient) for acceptable teaching of elementary mathematics. Where possible, these competencies are expressed in behavioral terms.

   For example: "Given a problem in multiplication of fractions, the teacher can draw a diagram or picture to illustrate the problem and its solution."

2. Accompanying each module there is a pretest which covers the objectives of the module. Thus a teacher who had already attained a particular competency would not be required to study the related portion of the module.

3. The modules make use of existing instructional material; elementary school mathematics texts, texts on methods and content designed for teachers, films, and so forth. Where possible, alternate routes to the attainment of objectives are provided.

4. The modules make regular use of either real or simulated teaching performance. Paper and pencil test performance is necessary but not sufficient for completion of these modules.

5. The modules are so designed that local educational personnel can use them with minimal training. They have some built-in self-study avenues although the presence of a knowledgeable instructor is an advantage.

6. The modules each have a post test and often a parallel form of the pretest. Because the objectives define what we have judged to be minimum competencies, a teacher is not considered to have completed a module until she has attained all of the listed competencies.

The production schedule for these modules is as follows.

Completed: Teaching Concepts of Fractional Numbers
Teaching Addition and Subtraction of Fractional Numbers
Teaching Multiplication and Division of Fractional Numbers
Using Drill Activities
Teaching Geometry
Teaching Measurement

By February 15, 1972: Problem Solving
Whole Number Concepts
Numeration
By June 30, 1972: Six more, titles uncertain

The modules which have been produced have been used in a variety of programs. During the Summer of 1971 one hundred in-service elementary school teachers from the Atlanta Public Schools attended a three week inservice program based on the three modules on fractional numbers. During the Fall of 1971 a group of undergraduate Teacher Corp Trainees used the modules on fractional numbers and the module on drill as the basis of a methods course. Two groups of inservice teachers are using the materials in courses on the teaching of elementary school mathematics. During the Winter, Spring and Summer of 1972, use of these modules will be pilot tested and most likely implemented in the undergraduate methods course on campus. We expect that the modules will form the basis of a minimum competency program for preservice elementary school teachers in mathematics.

The pilot implementations to date indicate that students using modules often require individual attention. This is to be expected considering the fact that a student works in a module on his own pace and works on his own identified areas of weakness. It appears that a teacher-student ratio of 1 to 10 is more realistic during pilot testing than the traditional 1:30 ratio.

The Atlanta Public Schools pay for a share of the time of four faculty members of the University of Georgia Mathematics Education Department, several graduate assistants, a secretary, and supporting services. The College of Education, University of Georgia, contributes a share of time for two other faculty members and some faculty members have volunteered time to the project.

This project has been supported jointly by The Atlanta Public Schools and the College of Education, University of Georgia. The projected cost over the period from January 1, 1971 to June 30, 1972 is in excess of $100,000.

The development of the modules described in this paper was based on an investigation of the competencies of elementary school teachers in Atlanta. This investigation included testing teachers in the areas of content and methods and observing the teaching of mathematics in their own classrooms. The results of this investigation were similar to results of other studies of teachers' mathematical understanding: Many teachers are strikingly deficient in understandings of elementary mathematics. In addition, many teachers were found to need training in teaching techniques.

The evaluation which has been done at this time is informal in nature. Modules have been used in several settings and the characteristics of smoothly operating "workable" modules noted, as have the characteristics which lead to difficulty of operation. In writing other modules and in revising existing modules the authors have attempted to use the procedures and formats which have been found workable and to change or eliminate procedures which work poorly. In general, it has been found that the

program of study defined by the modules leads to the attainment of the desired competencies.

Deeper questions, however, remain to be settled. Are the competencies which we have deemed necessary for adequate teaching of elementary mathematics really necessary? Can evidence be found in the examination of children's learning to support or deny the contention that these competencies are necessary? Teachers operate under a wide variety of conditions; class size, intensity of supervision, internal motivation and other factors may be expected to influence their performance. Under what conditions are the competencies which teachers attain in the program evident in the classroom? Is there an observable relation between the attainment of the competencies, their evidence in classroom practice, and student achievement?

Observing that many teachers leave the classroom for a period of years leads us to ask, what is the "half life" of a competency? Are the competencies acquired for life, do these competencies need periodic review, or do they need re-verification after a period of absence from the profession?

These are examples of interesting questions which should be answered soon, as the move toward modularized education progresses.

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THREE NOVEL APPROACHES TO THE MATHEMATICS EDUCATION OF ELEMENTARY EDUCATION MAJORS

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I. Novel Approaches in the Required Mathematics Education Course

At The Florida State University, undergraduate elementary education majors take one 5-quarter hour professional course (taught by members of the Mathematics Education Department), Mathematics Education (MED) 421. This course has four mathematics prerequisites: Mathematics (MAT) 105, MAT 225, MAT 226, and MAT 227. All but MAT 105 are specifically for elementary education majors, and are taught by the Mathematics Education faculty; the course of study and text for MAT 225, MAT 226, and MAT 227 are determined cooperatively by the Mathematics and Mathematics Education Departments.

The topics for MED 421 are determined primarily by what is generally taught in contemporary elementary school programs; this coverage is not considered particularly innovative. However, certain strategies, the course setting and materials, and some related teacher training activities are novel.

First, the course is always taught concurrently with two others in the pedagogy of social studies and language arts. The purpose for this "block" scheduling is to permit students to work for at least ten full days in local schools (in lieu of attending university classes) on assignments specifically geared to their courses. For MED 421, such assignments include inventing and playing drill-type games with individual children, diagnosing and correcting learning impediments, supervisory drill, teaching small groups of children, etc. This participation has proved to be a successful link between "theory" and "reality."

Second, the course is largely a laboratory-type course. One classroom adjacent to the departmental offices is used for teaching all sections. It is equipped with spacious work tables as well as numerous shelves and cabinets housing materials (e.g., Dienes blocks, Cuisenaire rods, balance beams, Stern blocks, Geoboards, flannel boards, games, abaci, Mirror cards, Attribute blocks, childrens textbooks, etc.). Course instructors have developed exercises to help acquaint students with ways to

use these materials with children. In addition to such commerical apparatus (students purchase a Geoboard and a set of Cuisenaire rods), they are taught to make their own games and equipment, much of which they are able to try out with children during the course.

No commercially available text is being used for the course; but students receive some 250-350 pages of notes and exercises prepared by course instructors, together with article reprints.

II. An Honors Program in Mathematics Education for Elementary Education Majors

In addition to the regular program described above, a limited number of outstanding students participate in an Honors Program in Elementary School Mathematics Education. Beyond completing the regular program, honors candidates take additional courses in mathematics as well as a unique internship. The latter includes the conduct of a research study over and beyond the honors intern's in all phases of the regular school program--reading, science, social studies, etc., as well as mathematics. This research is related to some phase of teaching mathematics in grades 1-6.

The honors students complete their student teaching requirements at the FSU University School. They are the only elementary education majors who do their student teaching at this school. The student teaching experience is usually extended over a period of two quarters; the student works at the school for one half day each quarter, while taking 1 or 2 additional courses at the University.

Each honors student has a faculty committee which assists the student in the development and conduct of the research study, and supervises the student-teaching experience. The honors students write a major paper which reports on the study. An abstract is published in the University School Newsletter. The students also make an oral presentation of the report to the committee.

Students apply for admission to the program during the first quarter of their junior year. However, students can be admitted at a later date. The following requirements must be satisfied by all participants in the program:

(a) An overall 3.0 grade point average.
(b) A 3.5 average in all mathematics and mathematics education courses completed before the first quarter of student teaching.
(c) Completion of at least 12 quarter hours in mathematics, with credit in calculus and probability or statistics.
(d) Demonstrated acceptable teaching ability prior to the first quarter of student teaching. Students usually

fulfill this requirement by working under the direction of a faculty member for one quarter during the junior year. This experience is usually the conduct of a tutorial program for a small group of children in a local elementary school.

III. Teacher-aide Practicum for Elementary Education Majors in the Teaching of Mathematics

Elementary education majors have the opportunity to teach mathematics to children in grades 1-6 prior to the required participation (described under I above). The students who avail themselves of this opportunity work under the direction of a faculty member on an individual basis. The faculty member makes arrangements with a teacher in a local school for each student to work in classroom for one quarter. The student's responsibilities might include assistance in grading papers, working with a small group of children on remedial work, providing enrichment instruction, assisting with laboratory activities, and the conduct of games or drill exercises for the whole class. Each student meets regularly with the classroom teacher to make plans for their work in the classroom. The FSU faculty member also assists the students in preparing for their assignments.

All students working under the direction of a particular FSU faculty member meet periodically to discuss their participation. Each student is expected to write a brief report on his experience at the end of the term. The student earns 3 quarter hours of directed individual study mathematics education credit for this experience.

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MATHEMATICS EDUCATION FOR SURVIVAL

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"The thesis advanced here is that the primary goal in teacher education must be preparing teacher-persons who are able to interpret their environment through application of knowledge and understanding, who act intelligently and sensitively in the midst of dilemmas created by changing patterns and conflicts of a dynamic universe, and who aid their students to do likewise."[1] The problem of teacher education is, in the words of one teacher educator, "the problem of preparing teachers who can learn with everybody else how to live in a breathtaking vortex of change in the cultural and material conditions of the human community." The priorities in designing innovative or experimental teacher education programs for the future must be established with this end in mind; in fact, the entire structure of teacher education programs must be consistent with the outcome.[2]

The Michigan State University Elementary Teacher Education Program is based on the assumption that the knowledge and performances most desirable and necessary for man today are those that will directly enable them to survive in the present and future; that is, the knowledge and performances that will enable them to explain, predict and control their harmonious existence.

In the area of Elementary Mathematics Education the program presented is an attempt to deal with the viability of the answers to the following teacher education questions in relation to mathematics and the basic survival assumption. It provides the mathematics competency which is one factor in the development of teachers who can be accountable for the educational outcomes of their instruction. Questions: (1) What is teaching? (2) What is competent teaching? and (3) What does a teacher need to teach effectively?

1. Teaching is manipulating the variables of instruction to produce intended changes in learner behavior.[3]

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[1]Henderson, Judith and Lanier, Perry, Competency/Performance Based Teacher Education: A Paper for Discussion, January 1972.

[2]Mills, Patricia, "Which Way is Up," Some Cautionary Notes to Model Builders in Teacher Education," Journal of Teacher Education, Vol. 21, No. 4, pp. 496-497, Winter, 1970.

[3]Henderson, Judith, Education 200 Handbook: The Individual and the School, Winter Term, 1972, Pub. each term by Michigan State University.

selected by the teacher are both desirable and appropriate for the learner(s), and (b) the intended changes are actualized as a result of instruction.

3. A teacher needs to have product knowledge, information processing skills, and problem solving ability and in order to be competent as a classroom teacher he generates these behaviors in those students for which he is responsible.

The task of providing an appropriate integrated experience for 40 Michigan State University freshmen students is carried out by a team comprised of personnel from the department of mathematics, elementary education, and classroom teachers.

The mathematics program development and instruction team consists of four faculty members in mathematics education and three doctoral fellows.

In the area of instructional responsibilities this team is responsible for product knowledge, information processing skills, freshman instruction design and evaluation.

Five doctoral fellows and 4 classroom teachers are responsible for selection of elementary students and evaluation of the freshman's instruction in the Clinic School. A second phase of responsibility is to act as a facilitator for the integration of the Fall and Winter term Social/Emotional and Learning classes as they relate to the school experience instruction.

The freshmen will teach the 134 elementary students, in the public school, who scored below the 15th percentile on the state assessment tests.

The following is a description of the mathematical experiences in which the freshman students learn mathematics in formal and informal situations and at the same time consider the implications of teaching these ideas to children. In addition, the freshmen are involved in clinical experiences where they actually practice teaching mathematics to children.

The integrated mathematics courses for the third term freshmen meet 8 hours a week for ten weeks. It includes the integrated content and methods for (1) measuring, (2) numeration, (3) sets and attributes, (4) whole numbers, (5) rational numbers, (6) relations and functions, (7) counting, (8) probability and statistics, and (9) systems. During the junior year a second ten-week course is provided.

The composite experences, (80 class hours consisting of content and methods) and (a practicum consisting of 40 Clinic School hours), for the freshmen during their third term, as related to the development of a mathematics competency are:

1. VTR Presentation: Classroom teacher and students involved in mathematics activity (i.e., Week 1--Measurement) presents freshmen with examples if how topic for the week is taught in elementary schools and provides motivation for mathematics content involved.
2. (a) Assessment Test: Assessment of knowledge and comprehension related to the weekly topic.
   (b) Goals for week and term have previously been set by instructors.

(c) Students identify personal objectives for week from mathematics continuum and are set at this time.

3. (a) Experiences: Experiences provided for student to reach mastery and/or enrichment as they demonstrate mastery.
   (1) Activities provided for each assessed area.
   (2) Lectures provided for given concepts for those students not demonstrating knowledge and comprehension mastery from assessment or activities. (As necessary, whole or small group.)
   (b) Instructional Design for Application in Clinic School--A team of 4 students design a 4-day measurement unit for a specified group of children. The tasks of teaching which must be incorporated in the instructional design are: (1) assessment, (2) goal/objectives, (3) strategies, and (4) evaluation. These units are used in simulation and/or elementary teaching experiences.
4. Application-Instruction by Freshmen:
   Students implement instructional design at the Clinic School. Doctoral fellows act as feedback agent while teaching freshmen feedback skills and instructional evaluation techniques.
5. Evaluation of Instruction:
   This period consists of : (1) Feedback, oral, written and VTR. (2) Integrating the Learning and Social/Emotional class content with current experiences. (3) The freshmen developing personal objectives as related to the instruction experience which related to strategy and content for the topic area. These questions are then taken to the afternoon math class where independently, with help of methods instructor or content person the objectives can be attained.

Specific types of materials and facilities used in this program are: (a) an elementary public school and (b) the mathematics laboratories developed in the school and at the university.

There are presently no evaluation results available. Evaluation data will be available during the summer of 1972.

Types of researchable questions related to this project are: (1) Questions related to desirable teacher behaviors. (2) Effects on residual gain score of school children who are taught by prospective teachers during the ten-week term. (3) Do freshmen develop mathematics competency by the end of their third term? (4) Does the type of instruction received by the freshmen at the university affect their instructional behaviors in the elementary school?

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A COMBINED CONTENT AND METHODS LABORATORY APPROACH TO THE MATHEMATICS TRAINING EDUCATION OF PRE-SERVICE ELEMENTARY SCHOOL TEACHERS

John F. LeBlanc
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The Department of Mathematics and the Department of Mathematics Education at Indiana University are jointly developing an innovative program to train prospective elementary school teachers to teach mathematics. This program, whose development is funded by the National Science Foundation has two components: a teacher training component and a model elementary school component. The teacher training component of this program combines the mathematics content courses and the mathematics methods course taken by prospective elementary school teachers. In the state of Indiana 9 semester hours of mathematics content and 3 hours of mathematics methods are taken by the undergraduate elementary education major. These 12 hours are being integrated into a year-long program which will be taught in a laboratory setting. The model school component involves the development of a mathematics program in a local elementary school where prospective teachers will be able to observe good mathematics instruction and to practice teaching mathematics to children.

The basic motivation for developing the program is the belief that there is a need for a change in the pre-service elementary teacher preparation program in mathematics content and methodology. To rely on continuing in-service efforts as the major thrust in the improvement of mathematics instruction is felt to be quite unrealistic. While many mathematicians and mathematics educators seem to agree that as a result of the curriculum reform of the 1960's the mathematics curriculum materials are better and some of the content for children is better written; there is still an almost universal consent that mathematics is not being taught better. Teachers have not changed their techniques and they have not noticeably changed their attitude toward mathematics. It is probably not the teacher who is responsible for these shortcomings. It is, rather, the initial pre-service training of the teachers which needs reform. At most institutions the content component of this training has been taught by instructors who know little, if anything, about mathematics in the elementary school. Consequently, the level of the course has tended to be inappropriate, and the mathematics has seemed irrelevant to the student

since it has not been related to her professional goals. Another shortcoming in many pre-service teacher training programs is the lack of contact that the PST has with the elementary pupil. Often a PST will have no experience with children in a classroom until her senior year when her student teaching experience takes place. She has no experience with children to reflect upon as she learns mathematical content and methods. She therefore lacks a frame of reference for questions she should be asking relating to content and methods appropriate for the classroom. Still another shortcoming in some pre-service teacher education programs is the disparity in the mathematics methods classes between what the instructor does and what he says should be done. The PST is advised to use concrete materials and objects when she becomes a teacher, but such advice is rarely accompanied by experience in the methods classroom with such materials. A methods instructor might advocate that the prospective teacher incorporate pupil centered activities in her instruction. However, the methods course is taught in a didactic method so that the prospective teacher has no chance to learn in the manner which the instructor advocates. She will probably teach as she has been taught.

A fundamental assumption that underlies the program is that good mathematics teaching behavior by the prospective teacher can be fostered by modeling good mathematics instruction. Teachers tend to teach as they are taught. Another assumption is that learning mathematics ought not be reduced to a spectator role. The pre-service teacher must become engaged in an active role in the learning of mathematics if she is to elicit similar behavior on the part of her pupils later. Our project takes the position that prospective teachers should have early and frequent contact with pupils. This contact provides a basis for relevance, an opportunity to practice techniques she has learned and a perspective for earlier career decisions. The opportunity to use varied materials and techniques with peers should help prospective teachers acquire confidence and relieve the tensions about mathematics felt by so many of our elementary teachers. The laboratory (within our concept of the laboratory) affords the prospective teacher an opportunity to relate mathematics to the real world while becoming engaged in problem solving experiences.

The program will contain the mathematics content listed in the C.U.P.M. recommendations as well as methods for teaching elementary school mathematics. The teaching techniques and strategies are equal in importance to the content of the program. Appropriate instances of learning theory will be incorporated into the program. Opportunities to observe and work with young children will be made available. These components are interwoven through the instructional units of the program.

Currently, small portions of this program are being tried in content and methods classes at Indiana University to evaluate the materials and procedures. In the fall of 1972 two pilot classes involving a total of 50 students will be taught. It is a goal of the program to train all prospective elementary school teachers

(600 per annum) at Indiana University.

The project currently employs two full-time faculty members, one from mathematics and one from mathematics education; three half-time faculty members, two from mathematics education and one from mathematics; and ten graduate students, four from mathematics education, five from mathematics, and one from audio-visual. Once the program is under way, it is expected that the courses will be team taught by graduate assistants from mathematics and faculty from mathematics education.

The planning year of the project (June 1971 - June 1972) was funded by a National Science Foundation grant. It is hoped that this funding will be renewed in June 1972 for two more years.

This program will integrate and interweave the mathematics content (normally taught in the Mathematics Department) with the mathematics methods (normally taught in the School of Education). Furthermore, the program will use techniques and strategies that the pre-service teacher herself should use when she teaches. The pre-service teacher will learn mathematics by doing it. At times she will use activity cards or engage in peer teaching. At other times she will observe or teach mini-lessons to elementary school pupils.

The program which is being developed will completely intermesh the content and the methods. Instead of three content courses and one methods course, there will be one 12-hour content-methods program which will be taken by the pre-service teacher over a two-semester period of time. The content and methods will not just be mixed. As each mathematical topic such as addition of whole numbers, function or probability is developed, the instances of occurrences in the elementary school are also identified and studied. The pre-service teacher will observe children in a model school which is also being developed by the project; she will try activities which she herself has developed on peers and on children; she will have experience with diagnosing child errors and prescribing appropriate remediation; she will be placed in several open-ended problem-solving situations. At all times a focus will be kept on the teaching of mathematics to children without losing the integrity of the mathematics content.

At this point only informal formative evaluation of some of the project materials has been accomplished. (The amount of materials is about one-fourth of the program.) The evaluations to date support the concept of the program: the classroom atmosphere is pleasant and informal; the pre-service teacher seems to enjoy learning mathematics; the activity oriented approach to learning at this level seems to be quite feasible.

A number of researchable questions are evident. The whole issue of which content areas are most amenable to what teaching techniques is virtually unexplored, especially for pre-service teachers. It is at the core of the whole approach to determine where and when laboratory-type activities are appropriate for pre-service teachers and for the child whom they are preparing

to teach. Other important related questions have to do with the teaching of problem solving, the modification of pre-service teacher attitudes toward mathematics, and the impact of open-ended problem situations on the learner. Some work in these areas is being done by project facult and doctoral students but the need for the identification and research of other basic and instructional problems is strongly felt by the project faculty.

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A TUTORIAL-CLINICAL PROGRAM

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Olen E. Jones, Jr.
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Northwestern's recently inaugurated (1965) Tutorial-Clinical (T-C) Program in teacher education provides students with a flexible four-year involvement which consists of subject matter courses in the disciplinary departments of the University, tutorials in education, and a sequence of clinical experiences in a variety of schools and social agencies. This program eliminated all professional education courses and has specified teaching majors in subject matter fields for prospective teachers. Professional education is provided in small group tutorials and clinical experiences that involve prospective teachers in first-hand contact with children throughout their four undergraduate years. The program has as its essence flexible scheduling to encourage interdepartmental-intercommunity cooperation, and the elimination of preservice-inservice barriers. This approach, which was tested and refined over a six-year period, has developted into its present form through the cooperative efforts of students, faculty, members in subject discipliens, the School of Education, and educational personnel in schools who assist with the clinical experience core of the program. The program is accredited by the National Council for Accreditation for Teacher Education. A student may qualify for certification in any state, with careful program planning.

The curriculum revision involves the course of study in the area of professional education, approximately 20 percent of a student's work. Neither general education requirements, nor credit in major subject areas taken through the College of Arts and Sciences are affected, except insofar as interdepartmental cooperation is encouraged through the T-C program. Students preparing to teach high school develop a major in an academic area. Elementary teachers concentrate on two or three academic areas usually taught in elementary schools. The T-C program includes the following features in the professional education component:

(1) Sequential clinical experiences spread through the student's undergraduate years, thus giving cooperating school systems a key role in the preparation of potential school teachers.

(2) Tutorials to provide individualized assistance to students in the study of educational theory, knowledge, and practice, and the analysis of critical issues in the foundation fields of education. These latter studies are scheduled through

contracts between students and faculty advisers at times in the student's program when subject matter will have maximal relevance to clinical experiences.

(3) Small-group vari-durational seminars and workshops designed to foster insights into and understandings of the nature, issues, and developments of education in elementary and secondary schools.

(4) Opportunities for individualized planning through course work contracts which are developed between a student nd his faculty adviser.

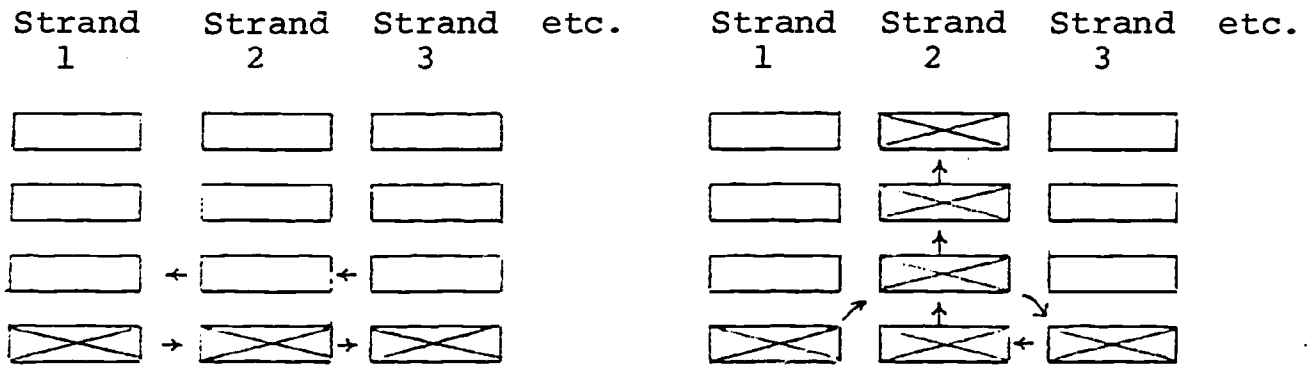
(5) Opportunities for advanced prospective teachers, during the last stage of the program, to serve as educational associates and counselors in the earlier phases of the program and to undertake research and other projects to improve their professional competence.

The Elementary School Mathematics Education Program

Current efforts in mathematics education at Northwestern are especially focused on problems in elementary school mathematics education. The program, as it relates to elementary school mathematics, is directed toward three distinct categories of students: undergraduate, graduate, and teachers in cooperating schools. The main objective of the program is, to develop the professional sophistication of these individuals concerning the construction, organi-ation, and implementation of small group learning experiences as opposed to dependence on pre-packaged curricula and materials. Specifically, the program is evolving with the following components:

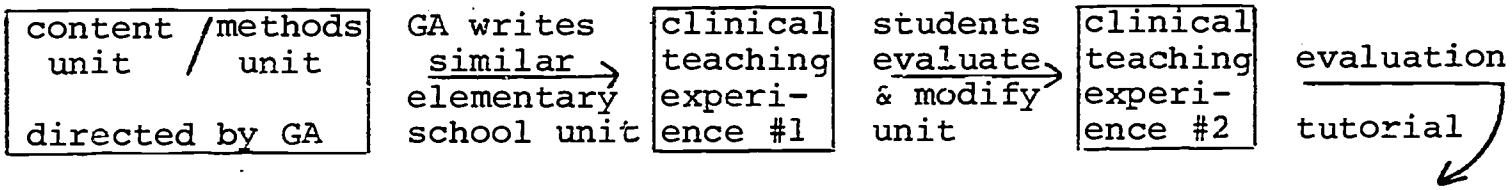
Pre-service Component: Through a grant from NSF, mathematics-methods instructional units are currently being developed at Indiana University, under the direction of Professor John LeBlanc. The equivalent of three mathematics content courses and one methods course are being consolidated into sequences of self-instructional units (approximately 2-4 weeks in length). Each unit is aimed not only at teaching content which is mathematically viable and mandatory for elementary school teaching, but also at demonstrating model laboratory teaching techniques (using concrete materials, discovery techniques, etc.).

Individual units are organized hierarchically within strands which reflect the scope and sequence charts accompanying most elementary textbook series. These units, however, represent a higher level of mathematical sophistication. By only slightly modifying the units being produced at Indiana, in order to mesh with the flexibility which characterizes Northwestern's total T-C program, students would not necessarily proceed through the units in the same order. For example, two students could complete units by working in various small groups in the sequential order illustrated in the following diagrams.



Under the direction of a faculty member, groups of 8-10 students are allowed to complete individual units on a contract basis under the close supervision of a graduate assistant. Therefore, the overall program is flexible enough to provide for maximum relevance and interest for individual students. The primary objective is for students to proceed "up" each strand while balancing this effort with breadth of experience in several strands.

Upon completing selected units, small groups of students are given clinical experiences teaching similar units to elementary school children. Such units are written by supervising graduate assistants under the close direction of mathematics and education faculties. Units may be videotaped and conducted with small groups of children and then in progressively more difficult teaching situations.



Graduate Component: Many of the most capable mathematics education doctoral students at Northwestern have expressed the need for clinical experience in research, observation, instructional development and student teacher supervision in the elementary school. Such instructional development and clinical experiences are an integral function of the graduate assistants within the previously outlined teacher training program. In order to prepare graduate students to participate in the above types of activities as well as some laboratory work in psychology, a sequence of four courses has been created to supplement Northwestern's other courses in mathematics education.

D75-Piaget: The Development of Logical-Mathematical Concepts	D70-Applications of Selected Psych. Theories to Math Educ.	D71-Instructional Development in Math. Educ.	D71-and/orE66 Research and/or Internship in Math. Educ.

D71 graduate students would be available to supervise groups of undergraduates in content-methods units, and to write short units for their clinical teaching experience in an elementary school.

In-service Component: At least one North Chicago school system (Winnetka, under the direction of Dr. Lola May) has had a laboratory curriculum in operation for several years. Other schools in the North Chicago area are greatly interested in implementing mathematics laboratories in their schools. However, mathematics consultants are considered to be a luxury by many systems. Nonetheless, "shipping in" a packaged mathematics curriculum without a consultant and without involving the teachers in the developmental efforts usually condemns a potential curriculum innovation to failure.

Because of these problems, a number of school systems have expressed interest in a cooperative effort (coordinated by Northwestern) which would furnish some consultant sources, in-service training for teachers, and a center for the development of instructional programs and materials in return for increased participation in the training of pre-service teachers and closer cooperation with the University in research and developmental efforts.

In order to satisfy the above needs, and to encourage the breakdown of artificial inservice-preservice teacher training barriers, in-service teachers are subsumed whenever possible into the same instructional program as the pre-service teachers. This leads to a two-way learning experience with both pre-service and in-service teachers working together cooperatively in small groups.

Each of the individual components of the program are either completed or currently being completed. The total program is expected to be in full operation beginning September, 1972.

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THE MATHEMATICS LABORATORY: AN INTEGRAL PART OF THE PRE-SERVICE TRAINING OF ELEMENTARY SCHOOL TEACHERS*

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Various learning theories, such as those of Piaget, Bruner, and Dienes, imply that activity centered learning experiences with concrete materials promote the development of concepts in children. Numerous research projects have substantiated that children do learn the traditional material of the mathematics curriculum as well as more sophisticated mathematical ideas using these materials and methods. However, one thing is certainly apparent. Children can make discoveries only if the teacher is prepared to set up the situations which give rise to them. It is through influencing the teaching staff that meaningful changes in classroom objectives, atmosphere, and organization can be realized. A viable alternative to the current method of presenting mathematics for pre-service elementary school teachers is the mathematics laboratory. The math lab can provide the blending of content, learning theory, and pedagogy which will enable prospective teachers to reorganize mathematics classes in the elementary school. This is the ultimate aim of the project at the College of Saint Elizabeth.

Previously, during each semester of the junior year, prospective elementary school teachers at the College of Saint Elizabeth took a three-hour methods course. The present project integrated these into two courses called Fundamental Concepts of Mathematics I and II carrying four semester hours of credit each. Approximately forty students who registered for this course were divided into two sections. Each section met for three one-hour classes and a two hour laboratory each week. All classes met in the room where the laboratory materials were available so that the use of the materials was not confined to the lab period. During the one hour classes emphasis was placed on developing mathematical concepts necessary for elementary school teachers. The laboratory periods provided an extended period of time in which to deepen concepts by the use of concrete materials and to devise ways of using materials with children. During November, 1971 each laboratory section made two visits to Assumption Elementary School in nearby Morristown, New Jersey where each pre-service

*This project was supported by a SPUR grant from the Esso Education Foundation.

teacher worked with four or five youngsters using the concrete materials of the College's math lab. During the Spring, 1972 semester, the one hour classes continued as in the first semester but the laboratory periods were spent with first, second, and third grade children in Assumption School.

The mathematics content of the first semester included logic, sets, relations, the system of whole numbers, numeration systems, algorithms, and bases. The staff sensed the need for a change of pace and so topics in nonmetric and metric geometry completed the semester's work. Coordinated with this material, one math lab employed Dienes' attribute blocks, people pieces, and creature cards in the study of sets and logic; in another, Cuisenaire rods were used to study relations. Napier's rods, slide rules, multi-base arithmetic blocks, geoboards, compasses, rulers and scales were utilized in other sessions. Occasionally, students worked through the problem cards associated with the concrete materials. Various publications of Zoltan Dienes were used. Dittoed lab sheets of activities devised by the staff were also distributed. Sometimes a group of students would select an appropriate experiment from the Laboratory Manual for Elementary Mathematics, which each group of four students had purchased. Each student kept a log book of the lab sessions which was used for discussion and evaluation.

During the second semester, the mathematics topics included a brief review of the system of whole numbers, followed by the study of the integers, elementary number theory, rational numbers, and real numbers. The equipment of the College's math lab was transferred to Assumption Elementary School where each section met for ten labor tory periods working with the first three grades. During each lab session, each college student spent forty-five minutes with a group of four or five children. The pre-service teachers planned activities in measurement which included conservation, comparisons, non-standard units, and standard units in relation to length, weight, liquid measure, and time. Activities in geometry included classifying, identifying and naming geometric shapes, studying the properties of figures, perimeter, area, and volume. as well as rotating and reflecting games described by Dienes and Golding in Exploration of Space and Practical Measurement. After the youngsters left the math lab area, the college students discussed objectives, outcomes, and problems encountered. Again, they kept log books. Several times during the semester, two members of the Education Department of the College of Saint Elizabeth met with the students and staff to discuss problems which arose in working with the children, and to help them evaluate their effectiveness.

The project was conducted at the College of Saint Elizabeth in Convent Station, New Jersey and at Assumption School, Morristown, New Jersey. At the college, the classroom was furnished with individual chairs and tables instead of the usual lecture chairs and had ample storage space for the concrete materials involved. At Assumption School, the sessions were held in the cafeteria and library, both bright and spacious rooms. Here, too, there was plenty of space for storage of the equipment.

During the past several years, the College of Saint Elizabeth invested about three hundred dollars in concrete materials to be used in a laboratory setting, including Cuisenaire rods, Algebraic Experience Materials (Dienes), attribute blocks, Madison Project materials, geoboards, Unifix materials, geometric shapes, and numerous mathematical games. Included in the grant from the Esso Education Foundation was five hundred dollars for equipment. A sample of the purchases made with these funds is as follows: multi-base arithmetic blocks, heavy duty scale, geoboard kit, mirror cards, probability and statistics lab unit, geometric figures, shape construction kit, thermometers, timers, rulers, yardsticks, demonstration caliper, and map measures, as well as a selection of paper and stationery supplies.

One section of the course was taught by this writer, a candidate for the Ed.D. at Teachers College, Columbia University in the Department of Mathematics Education. The other section was conducted by Sister Anita Sibilia, M.P.F. who received the Ed.D. from Pennsylvania State University. Three laboratory assistants, undergraduate mathematics majors with an interest in education, worked with the pre-service teachers, under the direction of the instructor. The instructor and one assistant were present during each lab session. The assistants helped in preparation of materials and were responsible for storage and upkeep of the equipment. In addition, during convenient, specified hours, they were available for individual or small group instruction in mathematics.

We feel that this use of the mathematics laboratory is one way to improve the effectiveness of the mathematics training of future elementary school teachers. It integrates the study of mathematics with the methodology of teaching mathematics, by providing students with the experience of using mathematical materials to aid in concept formation and then giving them the opportunity to work with children in small groups in a laboratory setting.

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A MATHEMATICS MINOR FOR ELEMENTARY EDUCATION MAJORS

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One of the most frustrating experiences in curriculum development at the college level involves updating curricular requirements for preservice teacher education. Having found it virtually impossible to increase course requirements in mathematics for elementary education majors, it was necessary to seek alternate means of meeting the needs of interested students and to encourage more students to improve their mathematical background. One alternative attempted in the College of Education at The University of Akron, Akron, Ohio, is a sequence of specially designed courses in mathematics content and methodology for elementary education majors.

The rationale for developing such courses is based on the local situation at The University of Akron. All elementary education majors must select an area of specialization which acts essentially as a minor area of study. Mathematics has not been a very popular area of specialization since the mathematics department has not been able to develop or staff courses for elementary education majors. With the development of a sequence of specially designed mathematics courses in the College of Education, it was the desire of the staff to encourage more students to select mathematics as an area of specialization. During the past two years the number of students selecting this special sequence has increased from one per quarter to eighteen (18) per quarter with a total of 51 students involved in the total program to date. Although this may not appear to be a significant number of students, we believe that any increase in the number of teachers possessing a more adequate mathematical background and entering the elementary classroom is significant. We believe that the number of students in this program will increase due to our constant "advertising" in our regular methods classes.

The sequence of specially designed courses consists of five courses (18 quarter hours) which the student may elect after completing the general University mathematics course (3 quarter hours) and the regular methods course in mathematics (5 quarter hours). These courses are entitled:

Geometry and Measurement in Elementary School Mathematics
Structure of the Number System in Elementary School Mathematics
Properties of Numbers in Elementary School Mathematics
Materials and Laboratory Techniques in Elementary School Mathematics
Independent Study.

In these courses, both content and methodology are emphasized. For example, in the geometry course the student studies, in detail, the material most appropriate for the elementary grades, constructs necessary models and materials, and investigate several teaching strategies suggested by texts, journals, and individuals.

In the structures course, concrete examples lead to the study of groups. Much of Dienes work is used to show how simple games can be analyzed and a mathematical structure can be constructed. Rings and fields are introduced and then the systems c natural numbers, whole numbers, integers, rational numbers and real numbers are classified. Most of the methodology involves demonstrating the mathematical structure of games children play.

The properties course is essentially a simple number theory course with a generous sprinkling of history and pattern analysis and development. The relationship between geometry, arithmetic, and algebra with respect to number patterns is demonstrated and studied.

In the math lab course, students investigate ways of conducting math labs on an individual, small group, or entire class basis. Models, experimental materials and games are developed. Mathematical experiments are investigated and developed. Mathematical objectives for games and experiments are determined and students gain much practice in setting up procedures for conducting experiments. An attempt is made to pool the mathematical knowledge gain in the previous courses and to utilize this knowledge to develop sound mathematical experiments useful at the K-8 levels.

The independent study course is usually a culminating experience which the student may investigate in depth a particular problem, or research a particular problem or methodology, or attempt to use materials developed in the program on a one-to-one or small class basis in an elementary school.

The staff involved in the present program includes two associate professors with terminal degrees in mathematics education and a graduate student in elementary mathematics education.

The usual classroom facilities are utilized. Students presently are supplying their own tools, materials, and our library holdings are very adequate for resource information. Requests have been made to set up a facility for the mathematics laboratory.

Feedback from students is very favorable and all indications lead to an expectation of further increase in the number of elementary education majors selecting our program as their area of specialization. A researchable question may be: does the program lead to the preparation of elementary teachers who have made significant gains in mathematical background, methodology, and attitude?

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A MATHEMATICS COMMUNICATIONS COMPONENT OF A PRE-SERVICE ELEMENTARY TEACHER EDUCATION PROGRAM

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As a result of a reorganization of the elementary teacher education program at Illinois State University, the role of the mathematics component was re-evaluated. Since the professional education part of the total program was reorganized around three cores (arts, communication, natural and social sciences), it was natural to include the experiences usually offered in the elementary mathematics methods course in the natural and social sciences core. A consideration of the role of mathematics in communication, however, suggested that pre-service elementary teachers might derive significant benefit from a consideration of mathematics teaching from this viewpoint.

Two restrictions were naturally imposed on any experiences in mathematics education provided in this core. First, since it is a professional sequence, the experiences would have a pedagogical emphasis. Second, since this would increase the time allotted in the pre-service elementary teachers total program for mathematics education, it would have to be limited.

Consequently it was decided to provide these experiences in a pilot program in the form of independent activity modules. Each module contained the following sections:

1. General Objectives, designed to give the pre-service teacher a general notion of the broad goals of the module.
2. Performance Objectives, designed to present, in behavioral terms, the specific desired outcomes of the module experience.
3. Suggested Procedure, designed to suggest specific activities including readings, mathematics laboratory experiences, student interviews, or other projects which would directly aid the student in attaining the objectives.
4. Bibliography, designed to provide a list of both basic readings and supplementary readings that would provide background material valuable in understanding the ideas of the module.

In each module an attempt was made to provide for active involvement, opportunity to proceed at ones own pace, and opportunities to interview and observe children's reactions to at least one aspect of the ideas in the module.

Since this experience would procede the usual elementary mathematics methods experiences, it was felt that the opportunity to communicate with children prior to a discussion of specific

methods of presenting mathematical ideas might be quite valuable.

The focus in the child oriented portions of the modules was on "getting a feel" of what children know, how children feel, and how children communicate this knowledge and feeling about certain central mathematical ideas to others.

It was also felt that the opportunity to take greater responsibility for one's own learning that these modules afforded the pre-service elementary teacher might be valuable preparation for discussions and activities about childrens' learning which might ensue in a follow-up mathematics methods course.

With these goals and conditions in mind, the following outline for the Core II experience was prepared and a subset of the modules listed were developed.

COMMUNICATIONS CORE (II)--MATHEMATICS COMPONENT

Experience Area I: Number--The Universal Language

Activity Module 1 - Communicating about "How Many" (From the very small to the very large--investigation of animal, children, and adult means of perceiving, using, and communicating number concepts. An interview might be conducted.)

Activity Module 2 - Names for Numbers--The role of symbols in communication (Various aspects of numeration, from ancient systems to the use of the binary system in space communication. Experiences might include video taping demonstration techniques or making a bulletin board.)

Experience Area II: Logic--The Language of Careful Reasoning

Activity Module 3 - Does Anyone Use Logic? (Analysis of reports, famous documents, everyday conversation, and advertising, Adult and Children logic interviews and experiments.)

Activity Module 4 - A More Formal Look at Logic (A study, using programmed material, of the basic logical connectives and commonly used inference patterns. Teaching children one aspect of logic.)

Experience Area III: Computers--With a Language All Their Own

Activity Module 5 - Flow Charting--the art of giving and taking directions (Experiences in interpreting and making flow charts, specifically related to commonly used algorithms.)

Activity Module 6 - Communicating with the Computer (Development of the fundamentals of the BASIC language. Experience using a time sharing terminal to investigate certain procedures used in the elementary school and to develop and use a simple fact practice program for children. Computer assisted instruction investigated.)

Experience Area IV: Other Ways to Communicate Via Mathematics

Activity Module 7 - Geometry--The Medium is the Message (A look at the artistic and communicative aspects of geometry. The role

of pattern and motion and design. Investigation of creative approaches of children through geometry.)

Activity Module 8 - The Language of Probability (Analysis of probablistic statements and opportunities to conduct probability experiments. Brief look at language of ratio, percent.)

Activity Module 9 - Pictorial Communication (Interpretation and construction of graphs used to display information. Opportunities to make graphical displays.)

Experience Area V: The Role of Communication in Teaching Elementary School Mathematics

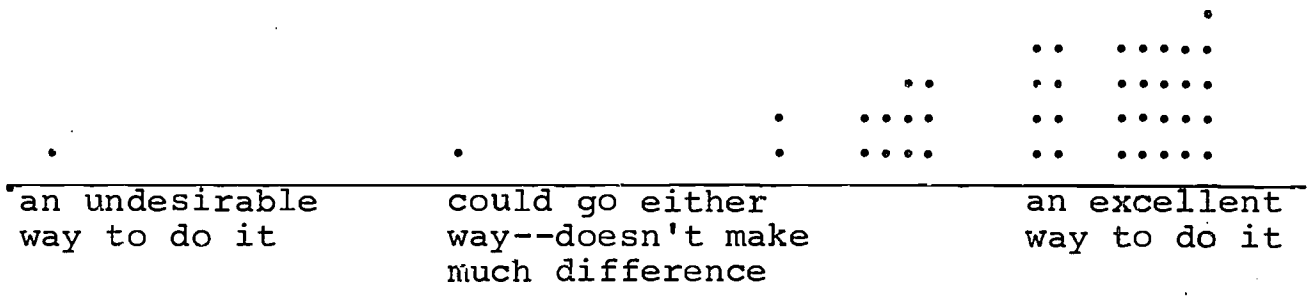
Activity Module 10 - The Mathematics Laboratory - Involvement <=> Communication (Role of communication between students and between student and teacher in the mathematics laboratory.)

Activity Module 11 - Teaching and Learning Strategies--modes of intercommunication (Role of questioning, discovery, non-verbal awareness, etc. Micro teaching opportunities enabling students to attempt various techniques for communicating mathematical ideas.)

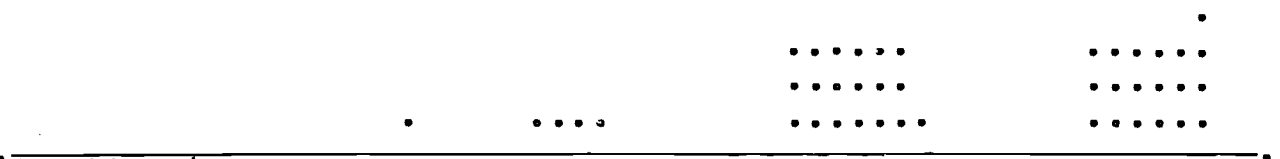
In the fall of 1971, forty-three students participated in Core II and experienced the mathematics component. As had been suspected, the outline presented above contained too many modules to be completed by the students in the time allotted. The experiences provided valuable suggestions for future improvement of the modules that were used. The usual testing procedures and the results of some questions designed to investigate the students' attitude toward mathematics indicated that the modules had been reasonably effective not only in helping the pre-service elementary teachers expand their knowledge, but also had changed their attitude toward teaching and learning.

The tallies on selected items from a questionnaire designed to evaluate the students' feelings about the module approach to instruction are given below:

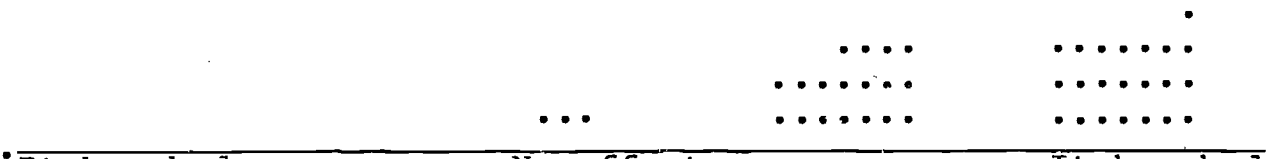
> What is your general reaction to the use of activity modules, with objectives, suggested procedures, etc. as a method of presenting this course?



If time requirements are not considered, how do you rate the module approach as a means of promoting your learning?



How has this course affected your feelings toward teaching elementary children mathematics?



This pilot project suggests that a mathematics component of a communications core might be valuable, and that an approach using activity modules may have some advantages. Perhaps the co-operation between the mathematics department and the elementary education department suggested by this summary might stimulate similar cooperation in other instutions. Also, the outline and the modules suggested might be considered as a spark to stimulate development of improved programs, possibly using instructional modules, for elementary teachers.

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A PROGRAM FOR THE DEVELOPMENT AND EVALUATION OF PROCEDURES FOR PREPARATION OF TEACHERS OF ELEMENTARY SCHOOL MATHEMATICS IN OPEN AREA SCHOOLS

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University of British Columbia

NOTE: This summary is limited to a description of the mathematics segment of the total program which includes all major elementary school disciplines. Director of the project is Dr. William A. Gray III of the Department of Educational Psychology at the University of British Columbia.

Teacher education programs at the University of British Columbia, and elsewhere, have failed to provide adequate preparation of open area school teachers. At the same time, the use of materials, activities, laboratory methods, games, and techniques for individualizing instruction and promoting continuous progress in mathematics has increased enormously. The student teacher is confronted with multiple problems incurred by changing school settings and changing instructional techniques in teaching elementary school mathematics. This project attempts to pilot a teacher education program which will train teachers to teach mathematics more effectively in open area elementary schools.

Observations and experiences in the exploratory phse of the project in an open area school in Vancouver suggest that there are specific skills, teaching strategies, activities, and interactive experiences between pupils and teachers which promote effective mathematics instruction and increase teacher self-perception in mathematics concepts and teaching skills. Formative evaluation and assessment of procedures based upon feedback exchange among student teachers, sponsor teachers, and university instructors has resulted in acceptance of a model of instruction based upon desirable pupil outcomes. The model to be described later can be used with three types of teaching-learning situations in the open area school.

The mathematics content for student teachers will be given during the first term with four weeks reserved for practicum in the open area school. In order to better prepare student teachers for the various types of teaching-learning situations in the open

area school, the instruction in mathematics will include teaching-learning modes prevalent in some open area schools. Three distinct modes of instruction for the open area school have been identified by Bethel.[1] These modes of instruction differ in extent of teacher dominance, degree of overt pupil participation, size of group, and opportunity for individual study. Briefly, these modes of instruction are as follows:

a. Formal Teacher Instruction - In this mode, not to be confused with didactic instruction, the teacher using expository techniques for groups up to full class size, is the dominant figure. Interaction between teacher and a particular pupil may occur frequently, but here the teacher's role is largely the transmission of information and laying the groundwork for assimilation of concepts and principles in subsequent teaching-learning modes.

b. Interactive Experiences - Here the teacher becomes less dominant, more in the role of moderator. Groups are smaller, pupils interacting with each other, suggesting ideas, methods of attack, related concepts, alternate procedures, etc. Each pupil is encouraged to share in the resolution of the problem or clarification of the concept. The teacher interjects or guides the discussion when the group reaches impasse.

c. Resource Learning Centers - Here the teacher has already almost fully played her role and leaves the stage after directing the pupil to the learning center according to need. The learning center offers further reinforcement of concepts, enrichment, motivation, drill, and challenge, using activity oriented materials.

In the second term, mathematics teaching methodology will be taught except for four weeks to be spent in the open area school. Instruction will be given in methods of team teaching, individualizing instruction in mathematics, utilization of materials and media, promoting continuous progress, and development and use of learning resource centers.

Between ten and fifteen student teachers in the fifth year graduate transfer program at the University of British Columbia will be randomly selected from between twenty and thirty volunteers for the project. In the first year exploratory phase of the project the first twenty volunteers from the fifth year graduate program were accepted.

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[1]This three dimensional categorization of the teaching-learning activities in the open area is due to Barbara Bethel, one of the sponsor teachers in the Queen Elizabeth School in Vancouver.

For each major discipline in the elementary school program a university instructor has volunteered to design the instructional program and supervise the preservice training of the student teachers. Two supervising sponsor teachers experienced in the first year of the project are expected to lead two teaching teams whose other members will be student teachers from this year's program.

The project is supported by a grant of $46,700.00 from the Donner Canadian Foundation. In addition, funds were allocated by the University of British Columbia for purchase of a mobile videotape van. In the second year, additional funds are expected through university research grants to university instructors in the project.

University personnel working jointly with school personnel and operating with a mathematics goal referenced model will establish a mathematics teacher education pilot program designed to provide the teaching skills suited to open area school mathematics instruction. The model encompasses four sequential considerations as follows:

a. What are the desired pupil outcomes of mathematics instruction? (Goals of mathematics instruction)

b. What are the conditions which produce the desired outcomes? (School mathematics instruction program)

c. What knowledge, skills, and competencies are required by teachers to provide the conditions which produce the desired outcomes? (Goals of mathematics teacher education)

d. What are the conditions which bring about the competencies needed by teachers to provide the conditions which produce the desired pupil outcomes? (Teacher education program)

The teacher education program in mathematics will be designed to demonstrate techniques of three teaching-learning situations in the open area school as described in section 3. Thus formal instruction will be supported by interactive experiences among students and use of learning resource centers prepared by the instructor. For example, the instructor will introduce a unit on sequences and limits, follow the formal instruction with some interesting problems to be considered by smaller groups, and finally direct individual students to learning centers containing activities which challenge, enrich, or reinforce limit concepts. Such an activity might relate probability and limit concepts. Methodology instruction will include team teaching, understanding and selecting teaching strategies, individualizing instruction, use of job cards, contract systems, use of media. Finally, the videotape will be used by each student during the four week practicum in each term. The student himself will select some specific aspect of his teaching for videotaping to make a self-analysis and evaluation of his teaching.

In the first term of the project's first year student teachers were in the open area school for nine weeks. During that time university instructors also held classes in that school in a room provided for that purpose. Much less time, about half the regular mathematics instruction time, was available due to the school experience. Nevertheless, students in the project performed slightly better on a final examination in mathematics than students in the instructor's regular mathematics class. A questionnaire indicated that students regarded the program more favorably and had a better attitude in mathematics than regular students. The experience gained in the preparation of mathematics learning centers appeared to increase this positive attitude. Such learning centers included fraction concepts, geometry, measurement, place value, graphing, algorithms. Observations in the first year suggest the following hypotheses: When compared to regular students, students in the open area will:

a. Perform as well on mathematics achievement;

b. Perceive themselves as better able to teach elementary school mathematics;

c. Have a more positive attitude toward mathematics;

d. Have a wider variety of instructional skills (teaming skills, alternate teaching strategies, individualized instructional techniques, use of media, use of materials).

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SECTION THREE

PROMISING PRACTICES IN METHODOLOGY COURSES

ELEMENTARY TEACHER EDUCATION PROGRAMS

The following seven paper describe new approaches to the teaching of pedagogy and methods in elementary mathematics education. These programs often include some teaching of mathematics content, and may involve short-term school experiences. Nevertheless, their primary focus involves the study and development of teaching practices in mathematics.

CURRICULUM AND INSTRUCTION IN ELEMENTARY SCHOOL MATHEMATICS

T. P. Atkinson and D. Sawada
University of Alberta

The procedure was devised to embody in the course ED. CI. 216 the methods currently advocated for elementary school mathematics teachers.

Two axioms provide the guidelines for designing the program by which to accomplish the stated purpose:

a. Prospective teachers should be taught in the manner in which they are expected to teach.
b. Because much of the content of elementary school mathematics is very familiar to teachers in training, the difficulties encountered by children learning basic concepts in mathematics are not evident to the prospective teachers.

The purposes of ED CI 216 are:

a. To provide understanding of the mathematical concepts involved in the current programs in elementary school mathematics.
b. To examine a variety of procedures for teaching the mathematical concepts developed at the elementary school level.
c. To examine the organization of topics in mathematics for Grades K through 6.

Although it is recognized that a practicum should be an integral part of any methods course, the teacher education program of which this experimental approach to ED CI 216 is a part offers practica which are not explicitly coordinated with particular methods courses.

Most students registered in ED CI 216 are in the second year of a four-year Bachelor of Education program. The course is compulsory for majors in elementary school mathematics and optional for others.

Three of the seven sections of ED CI 216 offered in the second term of 1971-72 are involved in the design. Each section has approximately 30 students.

Two staff members of the Department of Elementary Education, specializing in mathematics education, designed and are conducting the program. None other than the usual resources for offering a similar number of sections in the normal pattern was provided. However, team planning and preparation of materials require considerably more time than the normal program.

Corresponding to the axioms stipulated above:

a. The conduct of the class is based upon the activity approach: multi-media experiences, multiple embodiment of concepts and multiple instructional techniques--within an evaluation framework which emphasizes the formative over the summative aspects. The guided discovery technique is emphasized.
b. Because the students are so familiar with the names and numerals in the decimal system of numeration and because the basic facts and the algorithms associated with the operations are virtually second nature, it is difficult for them to appreciate the difficulties children in K-3 face in learning the concepts. To put the students into a situation more comparable to that of the children, the instructors have devised and used a numeration system which is based on five but with strange names and numerals.

It is not planned to use the devised system beyond the basic facts and algorithms except occasionally for illustration of ideas which are found in base then. For example, divisibility rules and point numerals are different for base five.

The project has been underway only since January 5, 1972. Plans for evaluation at this stage center around feedback to assess whether the program as planned has indeed been actualized in our classrooms. This preliminary "implementation" evaluation is seen as prerequisite before systematic "outcome" oriented evaluation is undertaken. The evaluation model underlying the project is that of Provus (1969). Plans are to emphasize the "definition," "installation," and "process" stages of the first term of the 1972-73 academic year, the benefits of the evaluation presently engaged in will be implemented in several sections of ED CI 216 and the later stages ("product" stage and "cost" stage) of the Provus evaluation model emphasized.[1]

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[1] Provus, Malcolm. "Evaluation of Ongoing Programs in the Public School System," in Ralph Tylor (ed.), Educational Evaluation: New Roles, New Means. The 68th Yearbook of NSSE, 1969.

AN INSTRUCTIONAL FACILITY FOR PRESERVICE ELEMENTARY MATHEMATICS EDUCATION

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W. W. Liedtke, J. H. Vance
University of Victoria

Prospective elementary teachers take their "Professional Year" in the Faculty of Education after having completed at least two years of university study. Their mathematics background includes at least one university mathematics course. The course usually taken, entitled "Fundamental Aspects of Mathematics for the Elementary Teacher," is offered by the Department of Mathematics and deals with such topics as sets, development of the real number system, systems of numeration, geometry, algebra, probability, logic, and history of mathematics. Instruction for the course is shared between interested members from the Mathematics Department and faculty in the Mathematics Education Section.

A one semester methods course in curriculum and instruction in mathematics education (Education 744), is part of the professional year. At registration students choose either a primary (K-3) or intermediate (4-7) program and are enrolled in a section of Education 744 which reflects this emphasis. The main topics and corresponding general objectives for the course deal with: the scope and sequence for the grades; the provincial curriculum; methods and strategies of mathematics teaching; the learning process; textual and manipulative materials; accommodating individual differences; and current trends. In the past the course was offered in a setting which was indeed rigid and traditional. The space available for these classes consisted of an "ordinary" lecture room containing arm-chairs, a blackboard and a small storage area for some of the materials acquired over the years.

During weekly meetings of the members of the section in the Spring of 1970, increased dissatisfaction with the teaching area was expressed, and a search began for an area which would allow the use of methods which were at least similar to those advocated for the elementary school classroom. An attempt was made to find an area which would make it possible for students to learn some mathematics through activities; an area where they could use aids and games, make instructional materials, search through recent references, and experience various instructional techniques ranging from large group sessions to individual projects.

Based on the above mentioned points, a proposal for a mathematics laboratory-type facility was drawn up and circulated to persons in charge of "space" allocation. A bid was made for either of two areas which possibly would meet most of the desired requirements. A list of preferred furnishings and a scale drawing of the possible arrangement for the setting were also included.

Instructional Area

The acquired space consists of three adjacent rooms. The largest room contains 17 trapezoidal tables which may be arranged in any one of a number of formations depending on the particular class activity, 30 chairs (leather upholstery), carpet, two large blackboards (one magnetic), two overhead projectors, a daylight screen and heavy curtains. One of the smaller adjacent rooms contains manipulative materials and games which are used for demonstration and group activities. The third room, furnished with shelves, tables, and chairs, contains texts, journals and various other recent publications which are used by students to prepare assignments for the course or lessons for practice teaching.

Evaluation

Although it is only the first year and the area is gradually becoming more operational, various advantages have become apparent. Many of these may seem to be minor in nature and are based on mere observation, but we believe they are a step in the right direction.

There appears to be increased interaction between students during scheduled sessions. As members of groups, students tend to interact with materials, with each other, and with the instructor more readily (when compared to the old setting). Attendance seems to have improved and if the evaluation forms completed at the end of the first semester are any indication, the students seem to appreciate and realize the value of the facility. In addition, many students indicated that the setting helped in improving their attitude toward mathematics. Frequently students can be found browsing through the area, looking at books or playing some of the games which are set up on a rotating basis. The extent to which there is positive transfer to the classroom beyond the methods course and practice teaching is yet to be determined.

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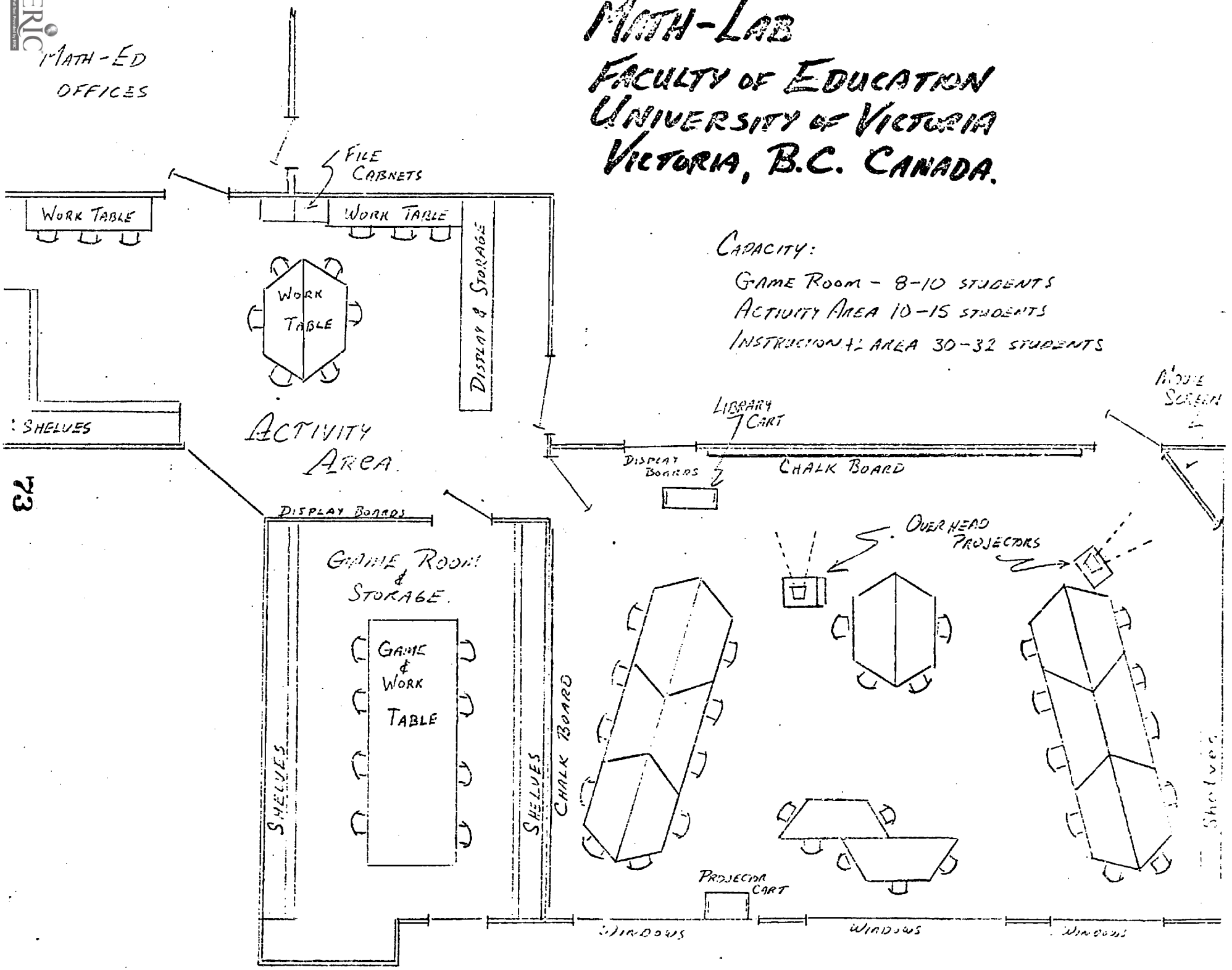
MATH-LAB
FACULTY OF EDUCATION
UNIVERSITY OF VICTORIA
VICTORIA, B.C. CANADA.



EVALUATION SYSTEMS IN MATHEMATICS EDUCATION

W. George Cathcart
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The focus of the approach outlined here is with systems for evaluating students in elementary mathematics education courses. During the past two years instructors in the introductory elementary mathematics curriculum and instruction course have used three distinct systems for determining a final grade in the course. One of these systems was the very conventional system of combining grades on certain assigned projects and on a final examination. The other two systems were experimental and are briefly described later in this paper.

The decision to experiment with the evaluation system arose from two major concerns. First, under the conventional value system students concentrated on the aspects of the course that would earn them marks and on trying to decide what would be asked on the final examination. Instructors felt that prospective teachers should approach the course with the attitude, "what can I get out of this course which will help me in teaching?" The second concern was that students were not as familiar with the mathematical concepts as they should be. A major thesis underlying the decision to change the evaluation system was that a reduction in the amount of pressure with respect to evaluation may create differences in the approaches students take to the course. For some students, the removal of the final examination may provide the freedom needed to pursue individual interests. This may improve attitudes toward the course and toward mathematics. For other students the removal of the final examination may provide the time needed to research the mathematical concepts they are unsure of, thereby improving their understanding of the concepts.

During the current academic year six instructors and 350-400 students have been involved in the program. This accounts for 100% of the elementary mathematics education instructors and 100% of the students who chose to take the introductory elementary mathematics education course in either semester. The students are in either their second or third year of a four-year Bachelor of Education program.

The two experimental systems of evaluation are outlined below:

1. Contract system: In the contract system students contracted near the beginning of the semester for a particular grade.

As the grade contracted for increased the number of assignments and the amount of work involved in the assignments increased. The contract, including the assignments is attached as Appendix A. (Grading at the University of Alberta is on a nine point scale from 1-9).

All assignments were graded as acceptable or rework. An assignment could be reworked as often as required to achieve an acceptable rating.

Students could recontract once about 3/5 of the way through the semester.

2. Point System: The point system was devised primarily to overcome the criticism that the contract system did not differentiate between the especially capable and the average student. In the points system, the same assignments used on the contract system were used (this will be changed in the future) but they were graded on a three point scale, 1 for weak, 2 for acceptable, and 3 for very good. Each assignment was given a weight. The number of points earned on an assignment was the weight of the assignment multiplied by the grade obtained. Any assignment could be reworked once. A student's final grade in the course was determined by the number of points accumulated. Appendix B outlines the system in more detail.

Research. Evaluation of the program to date has been only via observations. Most instructors report enthusiastic acceptance of the program and increased interest in mathematics.

A more formal method of evaluating the program is in progress in the current semester, but results will not be available until April or May. In addition, funds have been requested to conduct a more rigorous research of the program during the next academic year.

(Appendices specifying contracts and evaluation procedures are available from the author.)

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THE PLACE OF THE LABORATORY IN A METHODS COURSE FOR TEACHERS OF ELEMENTARY SCHOOL MATHEMATICS

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Professor Fitzgerald of Michigan State University had already adequately demonstrated the potential of the laboratory approach to content courses when the author and his colleagues began a new approach to the classic "methods" course in 1969-70.

Prior to that, the usual undergraduate elementary major enrolled in two 5 quarter-hour content courses and one three hour methods course. This latter course was being taught in the usual manner: three one-hour class meetings per week; in the main taught by graduate assistants. The total enrollment each quarter averaged 200.

The quality of instruction ranged from good to very poor. The most usual complaint from both student and in-tructor centered about the lack of relevancy to the classroom caused by the absence of classroom experience in the career of the instructor. A second level of complaint focussed on the notion that the student never encountered a member of the faculty of the Mathematics Education Department.

To accommodate these and other inadequacies of the methods course a new approach was designed and refined to its present state through three years of experimentation.

Today all elementary education majors enroll in one methods course. It is still a three quarter-hour offering but the individual student's weekly schedule includes: two one-hour large group lectures per week and a one and a half hour laboratory session. The lectures are presented by members of the faculty and such visiting professors who may be on campus.

The first lecture of the week, usually on Monday, is devoted to the theory and philosophy of contemporary pedagogy. The second lecture, usually on Friday, is devoted to specific classroom applications of the content of the week's laboratory. Of course, all appropriate media are used in the presentations. The attendance at these lectures will average about 150 students per quarter.

Laboratory periods are schedules throughout the remainder of the week so that no more than 15 students are in each laboratory session. A lab manual was prepared and is now available as a publication (a revised and expanded edition to appear this fall).

The manual is self-directing allowing the students to proceed independently of the laboratory assistant (a graduate student).

The activities in the manual, while written on an adult level, carry the student through a series of activities which

could be replicated by elementary children. Each laboratory is designed to present levels of difficulty appropriate for each elementary school grade level.

The principal purpose is to have the student teacher experience the laboratory approach to learning, to experience personal discovery, to experience differentiated instruction and to construct a resource notebook of some hundred tested classroom activities.

Evaluation of the program[1] exhibits growth in mathematical content and a quite positive shirt in attitude toward mathematics per se. An unexpected pleasant result has been in the changes that occur to the graduate students who now work with elementary education majors in a more relaxed atmosphere. It is difficult to document these changes but the author is convinced they do exist.

Once the initial experimentation period was ended there has been no real difficulty encountered. It does require a good deal more planning and supervision but the dozens of unsolicited complimentary reactions from the students has made the extra effort worthwhile.

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[1] Smith, Isabelle Lauree. "A Formative Evaluation of a Laboratory Oriented Preparation in Geometry of Preservice Elementary School Teachers," an unpublished Master's Thesis, University of Georgia, 1971.

CULMINATING ACTIVITIES IN MATHEMATICS EDUCATION

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According to one definition of Carter V. Good[1], a culminating activity is " . . . an exhibit, demonstration, or program by which a project or unit of work is brought to a significant conclusion." Activities, not considered as culminating activities, include such initial discovery activities as following directions for using manipulative materials and then, as a learning technique, recording the data of the model. The general purpose of culminating activities is to transfer learning to practical applications or to summarize the learning in a different setting.

At Kansas State Teachers College, there are six sections of the Teaching of Mathematics at the Elementary Level (Ed. 317). Some culminating activities are the same for all sections and some are different. Reasons for this are that the course if offered in a team teaching block of courses, and students are assigned to sections by their area of teaching interest such as grade level, special education, and concentration in physical education. In the course, all aspects of elementary school mathematics are presented in a laboratory setting using an operation on objects.[2]

The college student is introduced to child growth and development through a study of the Piaget experiments, a simulated demonstration of conservation and classification; and observation and discussion of the film, Piaget's Developmental Theory - Conservation.[3]

Each student in the early childhood education section tests one child in nursery school or kindergarten to verify that the particular child is the pre-operational stage[4]; and then the college student attempts to teach the child, with objects, such accomplishments as matching, counting, identifying the number of objects in a set, patterns in numbers, and the like.

The students are introduced to behavioral objectives primarily through the audio tapes and strip films produced by Vimcet Associates.[5] After experiencing this exposure to behavioral objectives, the students compile verbs that are behavioral in mathematics education.

In order to be able to write behavioral objectives, to relate these to learning activities based primarily on an operation on objects and to organize these objectives in reasonable learning sequences, each student writes a comprehensive set of objectives for his grade level of interest as a culminating activity for the entire course. Then, the student shows, usually by a depiction, how each objective is to be achieved and, thus, the emphasis is on an operation on objects as the initial learning base.[6]

Most students understand the value of these culminating activities as is indicated by an anonymous rating of instruction on a comparative scale. These objectives and operational activities for a given grade level could be the center of the curriculum in a conventional type of elementary school course or in such developing programs as open classrooms, laboratory teaching of mathematics and team teaching arrangements.

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FOOTNOTES

[1]Dictionary of Education, (Carter V. Good, Edition) McGraw-Hill Book Company, New York, 1959. p. 9.

[2]Transparencies showing such constructions are the fourth and sixth grade sets from Creative Visuals, Box 310, Big Springs, Texas 79720.

[3]Published by: Davidson Films, 1757 Union Street, San Francisco, California.

[4]Piaget Task Kit, Bureau of Measurements, Kansas State Teachers College, Emporia, Kansas.

[5]Vimcet Associates, P.O. Box 24714, Los Angeles, California.

[6]Modmath Set - (Teacher's Demonstration Model), Douglas Mfg. Corp., Box 150, Crete, Nebraska 68333.

MODELING THE MATHEMATICS LABORATORY WITH PRE-SERVICE ELEMENTARY TEACHERS

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If we believe that a laboratory, activity approach is a useful strategy in teaching mathematics in the elementary school, then is it productive to model this approach when teaching prospective elementary teachers? The above issue motivated the writer to incorporate 20 laboratory activities into the content of an elementary methods course. There were two treatment groups: treatment 1 (T1), a demonstration by the teacher of the activities in each of the 20 laboratory experiences, and treatment 2 (T2), a participation sequence by the students whereby they manipulated hardware and completed worksheets for each of the 20 laboratory exercises.

A room with adequate storage was made available and students in (T2) completed the laboratory experiences as an "out of class activity."

The expense was minimal. Most of the hardware was collected from departmental closets. The laboratory was not supervised. The writer "looked in" occasionally, but only out of curiosity.

Pre and post tests were administered to measure the student's attitude toward mathematics in general, and his attitude toward laboratories specifically. The statistical model was analysis of covariance.

The participation group (T2) had a better attitude toward mathematics and toward mathematics laboratories than did the observation group (T1). This was not significant at the .05 level, but the trend was apparent.

The modeling of innovative practices may be the most promising way to change teaching styles. If we preach but don't practice, the "pedagogical clout" of methods courses will likely suffer.

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PREPARING ELEMENTARY TEACHERS WITHOUT GRADES OR REQUIREMENTS

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The New School was formed to try to integrate the liberal arts with professional education, to break down subject matter boundaries, and to teach teachers as we would have them teach. To try to accomplish this, a new division was formed, separate from the (continuing) College of Education, with its own dean. The students take all of their junior and senior work in the New School, with no entrance requirements except those required by the University of all students, and the faculty was recruited from both liberal arts and education faculties. Although four credit course titles were created to satisfy the computer, both faculty and students initiate and terminate activities as they feel appropriate. A failing grade is impossible; the student's adviser reports the number of credits the student is to receive, have deferred (incomplete), or have withdrawn.

This organization has allowed individualizing and personalizing of teacher education similar to ways we would have teachers teach. Advisers can concern themselves with advisee's total education, with what advisees might best do at this time, considering where they are now, both in terms of what they know and how they feel, and what they might do next. Suggestions are made, but it is remembered that students learn much better when they are self-motivated. An adviser does not have to impose any particular requirements on his advisees, and students are encouraged to formulate and operate on their own beliefs about what will help them to become better teachers. Flexibility and individualization are optimized, limited only by real personal consideration of those directly involved. Students who decide on Thursday that they need to get into a classroom sometimes start working the following Monday.

I am the only full time mathematics specialist, but students sometimes do work in mathematics with other people who are interested. I have tried to learn how to work with students in ways which will actually accomplish a better learning environment for the children they will teach. It is most important for students to develop self-confidence and attitudes which will enable and encourage them to continue to learn, after graduation, how to do a better job of teaching mathematics. Teachers must want to learn, want to understand, both the content and students they are teaching. They must know that they can learn and understnad, on their own

or with the help of some other non-specialist, such as a child or colleague, something new that might confront them or one of their children. Teachers must realize, from personal experience, the value of manipulative materials, that there are some mathematical activities that are enjoyable, that there is room in mathematics for creative activity, that mathematics is not merely specific answers to specific questions. Teachers should know some things they can do in mathematics besides the text, and have the inclination to do them. They should know something about how to modify activities to make them appropriate for their teaching situation.

I no longer give tests, but even when I used to test I found the anecdotal and subjective evidence more important. In the New School I am getting evidence of successes qualitatively different from any I had in my previous nine years of working with teachers in mathematics. I also am getting much more valid evidence, by being able to observe and work with a number of students who I previously worked with and now have become full time teachers. I see how my efforts are later translated into classroom behavior. It is a tremendous opportunity, for making education more relevant, to be told by a student that he doesn't feel a suggestion I made was workable, and be challenged to come up with a more workable suggestion.

Students no longer come to me in fear of getting a low grade. They can openly communicate their fears, lack of understanding, and how they feel about what they are getting from activities without worrying about being judged a failure. With students who, in my previous experience, would have received D's because I could not overcome their previous history of failure, I can now find out what they feel they need, what they do and do not like to do, and can get them involved in activities they enjoy and can succeed in. I can, as Paul Nash put it, "use the student's professional interest as a focus from which he can move out in a liberating exploration" (Authority and Freedom in Education, p. 41; New York: John Wiley and Sons, 1966). Students have the freedom to pursue something when they are interested in it, to form their own questions, set their own conditions on the answers, and work on it as long as they wish without having to go to a class or study for a test (an opportunity I had only occasionally even in graduate school). They have an opportunity to think and create rather than just respond.

My most successful endeavors have been my "Open Math Lab," "Traveling Math Lab," and independent study projects. Any student who wants to can come to the "Open Math Lab" at any time I announce I will be there for that purpose. Students are free to stop and start any time. They can work with children's materials, like Cuisenaire Rods or the ESS Attribute Games and Mirror Cards; they can learn to play games like On Sets and Kalah, and they can make things, like an addition slide-rule, yardstick number line balance, soma cubes, tangrams, and geoboards. I make no general presentations, but work only with small groups or individuals.

One experienced elementary art teacher, who was in our master's program to prepare to teach in a self-contained

classroom, had only this open laboratory experience in mathematics before teaching grade six. She learned nothing of the field properties or other structure taught in most mathematics courses for elementary teachers, and she knew little of the sixth grade mathematics she was going to teach. What she had was a changed attitude. She knew she was weakest in mathematics, and she chose a mathematician as her adviser for the year. She did a very good job of teaching mathematics that year. She openly told the children she did not know much about mathematics, and they would have to help her learn it. They did. She attained most of the objectives of a preservice mathematics course. She also involved her children in a number of good activities, several she developed herself, relating mathematics and art, and she did a good job of individualizing and opening up the more traditional parts of her mathematics program.

For the Traveling Math Lab, I telephone a teacher who has asked us to come, finding out something of what she wants us to do, and what materials she has in her class. I meet with the students who are going (no more than 5), get them familiar with some things they can do with a group of children (no more than 6), and give them some things to work with on their own for further preparation. On longer trips (some are three days) I have a student drive, so I can teach the other students on the way. Each of us works with part of the class, allowing the teacher to observe how her children react to new people and materials. Frequently we get some children to help make some of the things we work with, so that there is a lasting residual in the classroom. By going into several classrooms the students learn how different children react to the same materials, and how the use of the materials might be adjusted to different children. By going on several trips the students become familiar with a great diversity of laboratory materials and how they might be used with children.

Independent study in the New School has been particularly valuable. Several students have surpassed me in their knowledge of some area of mathematics education, such a Nuffield materials, curve stitching, using Cuisenaire Rods with upper grade children, geometric solids. These students then give workshops about what they have learned for other students, and the other students get an instructor who knows more about it than I do. Those doing the independent study learn through direct experience that a student can learn more about something than the teacher knows, and they become familiar and confident enough with what they study to actually use it in their classroom, and can adjust what they have learned to fit the children they have in their classroom.

One implication of these activities is that I spend at least 30 hours a week in direct contact with students, but no time preparing lectures or tests. I concentrate my time on those I can most benefit. Another implication is that some students effectively avoid doing anything in mathematics. The New School probably turns out as many students poorly prepared to teach mathematics as any other department of elementary education. But I feel we help many students to change in ways quantitatively and qualitatively superior to those accomplished in my previous

experience.

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SECTION FOUR

INTEGRATION OF METHODOLOGY AND FIELD EXPERIENCES

ELEMENTARY TEACHER EDUCATION PROGRAMS

The eleven papers in this section describe programs which unify work in teaching methodology with extensive field experiences.

PERSONALIZED TEACHER EDUCATION PROGRAM

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The impetus for seeking alternate approaches to the professional preparation of prospective elementary teachers was the apparent lack of opportunity for intern experiences that reflected the real world of teaching. Furthermore, the seven individual components (courses) of the professional sequence were not perceived as an effective integrated whole by many prospective teachers as they moved into their first year of teaching. Needless to say, many students found themselves weaving their way through the requirements to become certified to teach and yet individually not really getting to know themselves as persons or to know other students and faculty as persons and professionals.

We believe that we, our students, and the children with whom our students work are unique human beings. We believe that all of us, or at least most of us, can develop adequacy and effectiveness in coping with living if given proper instruction and time to learn. We believe strongly that this growth will be enhanced if our self-esteem is not negated to insidious comparisons with others. Thus, the main goal of the Personalized Teacher Education Program (PTEP) is to maximize the potential of all (faculty, students, and children). The needs of the students and their unique characteristics should, as far as possible, determine the structure of the program. This does not mean that the faculty have no predetermined minimal expectancies for the graduates of such a program. They have. It does mean, however, that there are different experiences for individual students based on both personal and curriculum concerns derived from interchange between students and faculty members.

The two-semester program (30 semester hours) follows the completion of courses designed to provide necessary academic background. Included in the background courses are six hours of mathematics composed of selected topics to provide foundations in mathematics for elementary school mathematics programs. Also, each student has selected and most have complted an eighteen to twenty-four semester hour subject specialization chosen from a displya of sixteen areas (e.g. English, sociology, mathematics, Spanish, biology, etc.).

The program encompasses the requirements of six hours of introduction to teaching, three hours of educational psychology, nine hours in selected courses in the methods of teaching school subjects (reading, mathematics, science, language arts, social

science, etc.) and nine hours of student teaching. Opportunity is provided for students to take three hours in cultural foundations of education although at present it is not an integrated part of the program.

PTEP was first organized at the University of Texas for the 1968-69 academic year with twenty-six senior students enrolled in the program. About one half of that group requested to be in the program. Other students were advised to become enrolled as an assurance of being able to complete their degree and certification program. The program has been repeated during the 1969-70 and 1970-71 years with modifications and changes as recommended by the students and faculty. During the 1971-72 year, two groups of thirty each and two faculty teams were organized. For each, the process of selection was again similar. Beginning in Spring, 1972, another group was organized composed of junior students, all of whom elected to be in the program.

The faculty team for the program is composed of: one counselor, one instructor with specialization in learning and child development, one instructor with specialization in cultural foundations of elementary education, three instructors with specialization in general elementary education, two instructors to supervise student teachers; two principals of cooperating shcools, elementary teachers from two cooperating schools--one for each student teacher in the program; one coordinator (this person is one of the three staff members in curriculum).

Materials. In addition to selected books and bibliographical lists from individual staff members for purposes of implementing their responsibilities in the program, a collection of Curriculum-Based Personalized Instructional Modules developed by several members of the PTEP faculty in the Research and Development Center for Teacher Education at The University of Texas at Austin are used. Among these modules are self-directed guides for non-instructional management, instructional planning, personalizing classroom interaction, assessing and diagnosing student behavior, and subject oriented modules in the teaching of mathematics and the teaching of science.

Time. Students are committed to an 8:00 A.M.-4:00 P.M. day, five days a week. Faculty are allotted that time for corresponding course load regardless of program. For no faculty member is this their complete load.

Services. Counseling service and videotape equipment and personnel are provided by the Research and Development Center.

Financial Resources. Faculty salaries and supporting staff and services are provided by the University of Texas (Department of Curriculum and Instruction) and the Research and Development Center.

Content and Activities

Since PTEP is a personalized program, a collection of instructional activities are identified and utilized as individual needs indicate both interest and reception of these experiences.

Among experiences available are: seminars in introduction to teaching; interpretation of personality tests; initial teaching experience followed by videotape feedback with the personalized and curriculum team members; seminars on instructional strategies, psychological foundations of teaching, non-instructional management, personalized teaching, and social science; instruction in the teaching of reading, language arts, science, mathematics, and videotape feedback conferences of teaching through the program with curriculum team members.

Operationally, some structure is imposed on the sequence of experiences due to student concerns and needs, constraints of faculty involvement at all times, and registration procedures. Specific intent on the topics varies according to individual needs and interests. The following schedule provides the general nature of PTEP although variations are made in response to the interaction of students and faculty in a particular group.

Time	Nature of Experiences
Phase I (one week)	Observations in classrooms in cooperating schools
Phase II (three weeks)	Students work with three members of the faculty team in seminars designed to introduce them to the learning and development of children, and to two of the curriculum areas (reading, mathematics, science). Feedback is given on The Personality Assessment Battery.
Phase III (three weeks)	Students apply their instruction to actual classroom situations on a limited basis. Each is assigned to a different teacher in the cooperating school. Primarily, students serve the function as a teacher's aide although what they do is dependent on their readiness for assuming responsibilities.
Phase IV (five weeks)	Continuation of seminar period begun during Phase II. Feedback given on videotape session recorded during Phase III.
Phase V (six weeks)	In-school experience with focus largely on instruction involving both tutorial and group teaching experiences.
Phase VI (three weeks)	Students meet regularly with the third curriculum staff member in seminars for developing competencies for teaching in that subject area. Advance planning for Phase VII student teaching experiences.
Phase VII (nine weeks)	Student teaching is on a full-time basis. Each student is assigned to a cooperating teacher and supervisor. Beginning with a minimum required teaching load, responsibilities increase until the student assumes full responsibilities for the full day of instructional and non-instructional activities.

Phase VIII (three weeks)	Students select from a display of some 20-30 suggestions and also have the opportunity to identify their own interests. Such experiences include: special seminars on such topics as The National Teacher Exam, professional organizations, legal rights and responsibilities, teaching opportunities around the world, team teaching techniques, constructing tests; visitations to innovative programs; identifying and developing materials for learning centers and for teaching; and small-scaled research.

Prior to 1970 evaluation was primarily subjective on the part of the faculty team involved and the students who participated in the program. A more systematic evaluation has been undertaken beginning in the 1970-71 academic year. Data have been collected describing the performance of students in PTEP. These include interaction analyses based on videotapes made under controlled conditions at different stages of the professional sequence. Teachers and children in the school, university professors and supervisors completed evaluation of each student based on field experiences. Personality, psychological and demographic data were also collected. These data were used in a variety of analyses and correlational studies focusing on three main categories of concern:

1. the correlation between student characteristics and teaching strategies as demonstrated on videotapes;
2. the change in teaching strategies during the year as demonstrated on the videotapes; and
3. the correlation between student characteristics and teaching ability as assessed by individuals in different capacities based on field experiences.

Plans are now being made to collect data related to: longitudinal success of students; correlations using situations more typical than videotapes; and isolation of characteristics to predict students who will be more successful under a blocked arrangement than the traditionally fragmented program.

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MATHEMATICS METHODS PROGRAM

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All too often methods courses are presented in a university setting and techniques of teaching are discussed on a theoretical level. Practical involvement is left to the student's imagination. The following program is an attempt to combine the theoretical and practical aspects of a methods course.

This program is in its fourth year of operation at Boston University. The course is an elective for four credit hours. Two sections of the course are taught simultaneously. Inner city and suburban school systems provide the settings for the program.

Course instructors have established a working relationship with the elementary schools through their personal involvement with the children and the teachers. Throughout the duration of the program, instructors spend approximately 1½ days per week working with children in the schools. Math coordinators and principals from the participating school systems are frequent contributors to the class sessions on the university campus.

During the summer session (the month of June), this course is taught in its entirety in an elementary school. Classroom teachers and children are invited to attend seminar sessions. In this situation, materials and techniques of implementation are introduced through demonstration lessons with children.

For many university students this course establishes a working relationship with an elementary school which frequently evolves into a student-teaching and/or teaching position in the same school.

An all-university course evaluation has indicated that this experience was considered by students to be the most meaningful preparation for teaching provided during their undergraduate program. Follow-up surveys could provide more evaluative data as to the long-term effectiveness of this program.

The following is a copy of the course description presented to administrators of the participating school systems.

Course Description

EE 441 Methods of Teaching Mathematics, Grades K - 8

Enrollment limited to upper-classmen and graduate students.

Pre-requisites

One semester course covering the content of the elementary school mathematics programs (or equivalent)

Time commitments

Seminar - 4 hrs./week for 13 weeks within the university

In-Service - 2½ hrs./week in a public elementary school for nine weeks

45 min. - 1 hr. / primary grade
45 min. - 1 hr. / intermediate grade
Remaining time observing children in classroom setting

Seminar content

1 - Exploration of manipulative materials and programs designed to enhance instruction in mathematics, grades K - 8.

2 - Design of teaching techniques and activities for implementing the aforementioned manipulative materials.

3 - Examination of psychological theories of learning as they relate to learning of mathematics.

4 - Consideration of placement of materials in terms of the content sequence of the elementary mathematics program and with regard to cognitive, physical, social and emotional development of children.

5 - Discussion of problems encountered in the tutoring situations.

In-Service program

Each university student will work with a group of two or more youngsters for a period of nine weeks. Hours will be arranged to complement the classroom teacher's daily program.

At the end of each session, the university "math specialist" will provide the classroom teacher with (1) a brief description of the activities completed by the students, and (2) a copy of all games and materials utilized during the session. Upon completion of the nine-week sessions, university students will prepare a case study report of their work. This study will be forwarded to the classroom teacher. The report will include an identification of existing problems, a description of activities and materials employed in the tutoring session, an evaluation of the youngster's progress and suggestions for future work with the children. In addition, university students will present a workshop for teachers on the use of various mathematics manipulative materials. The materials selected for demonstration will reflect the experiences of the university students with children in the school, as well as requests from classroom teachers.

University Commitment to the Elementary School

1 - University students will be supervised by the course instructor. The supervision is not the responsibility of the elementary school classroom teacher.

2 - A workshop dealing with the use of mathematics manipulative materials will be presented to the teachers in the elementary school. Additional follow-up materials and guides will be provided. The course intructor will be available for consultation for the duration of the program.

3 - Demonstration lessons with youngsters will be provided by the course instructor.

4 - All materials and activities designed by university students and utilized in the sessions with children will remain in the elementary school.

Public School Commitment to the Program

1 - General introduction and tour of the elementary school for university students prior to the beginning of the working sessions with children.

2 - Identification of children who might benefit from this program.

Children selected on the basis of:
(a) need and/or desire for enrichment experience
(b) need for remedial work
(c) need for attitudinal change

3 - Willingness on the part of the teachers to participate in a workshop (previously described) and to discuss with university students the mathematics program existing in the classroom and the needs of the children.

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TEACHING MATHEMATICS TO EDUCABLE MENTALLY RETARDED CHILDREN AND YOUTH

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An informal survey of mathematics education programs over the years reveals a general lack of concern for training elementary and secondary school teachers in the instructional psychology of educable mentally retarded children and youth (E.M.R.). Teacher education programs, both basic and graduate, rarely provide the theoretical and clinical experiences that will enable the teacher to work effectively with E.M.R.s. Yet almost all teachers will have some of these children and youth in their school, often in their classes, and sometimes among their neighborhood acquaintances and family members.

The psychological rationale of the present program rests on the defensible assumption that E.M.R. children and youth can learn socially relevant mathematical concepts and skills if there is a close fit between the developmental readiness (Piagetian) of the learner and the difficulty of the concept or skill being taught, and if the teaching strategies are psychologically sound.

The program setting is a course in diagnostic and prescriptive teaching of mathematics offered by the faculty of the Mathematics Education Center. Clinical work in dyad situations is carried out with one or more children or youth by each teacher or teacher trainee enrolled in the course. Appropriate theoretical work, including readings and discussions of professional literature in mathematics in instructional psychology and in the area of mental retardation is carried on simultaneously with the practical work throughout the semester.

Enrollees are either students in mathematics education or in special education. The course is offered by the faculty of the Mathematics Education Center in cooperation with consultants from the faculty in special education.

Resources include the physical instructional facilities of a large state supported school for the mentally retarded located near the university, and the teaching and learning materials of the Mathematics Education Center. Each enrollee devotes at least 2 contact hours per week of instructional time to each E.M.R. and 2½ contact hours to the university course. Additional enrichment experiences for the teachers includes all day visits to six or more private or state-supported school for the E.M.R. during which time they observe teachers working with the children and youth, and also discuss with the teacher or supervisory staff the scope of the mathematics program and the teaching-learning problems and issues.

Evaluation of the instructional program is based upon the growth (criterion referenced) of the tutees as evidenced in the observations by the tutor and by the university professor. Weekly

detailed progress reports are made by each tutor and remedial procedures developed in the university course for use during the next tutor-tutee session(s). A case study for use by the regular teacher provides further insights into the growth of the E.M.R. Occasional comments by the school's administrative staff and by parents supplement the ideographic evaluative data.

Because of the dyadic nature of the instructional setting, researchable questions are mainly of the clinical type -- a la Piaget. However, with a sufficiently large N of dyads more rigorous designs can be employed. Illustrative researchable questions might be:

> What differences in the ability to conserve (quantity, length, weight, etc.) exist among E.M.R.s, slow learners, normal and talented groups of children and youth of the same mental ages?
>
> How can interpersonal compatability between tutor and tutee be enhanced in order to facilitate learning mathematics?

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INDIVIDUALIZED TEACHER EDUCATION

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Some three years ago the Elementary Division of the School of Education at the University of Colorado became concerned about the effectiveness of the undergraduate teacher training program. Students were complaining because of not having enough in-school experiences and also about the amount of restrictions placed on them with regard to election of university courses. The public school teachers were concerned because they played a minor role in the training of teachers. Also, school administrators were concerned about gaps in the students' course background, especially in mathematics, and the transfer of good instructional techniques to elementary schools.

A committee was organized to study thoroughly the problem and make suggestions for a new program which would allow more emphasis on individualization and grant more independence to students in their university training experiences. The planning committee was composed of the faculty of the Elementary Division, graduate and undergraduate student representatives, and teacher and administrator representatives from the public schools. Much emphasis was placed on polling students and cooperating teachers and discussion groups designed to pick their brains for ideas to incorporate into an "ideal" teacher training program.

For many years the University has had an emphasis on a strong arts and sciences background for elementary teachers. This emphasis is continued in the new program, but allowance has been made for more opportunity to elect courses rather than require specific courses. Since 1962, elementary students have been required to take only one mathematics course entitled "The Structure of Number Systems." In the new program, the mathematics requirement is two courses in mathematics at the college level. Though the original required course and "Geometry for Teachers" are recommended, a student may elect any two mathematics courses offered at the university except courses of a remedial nature. In addition to the mathematics requirement, the student must complete before his senior year courses in the following area: 6 hours of English language; 6 hours of literature (American, English, or foreign); a course in communication principles of instruction; 14 hours in the social science; two semesters of biology with a laboratory; two semesters of the physical sciences with a laboratory; a subject area minor or 20 hours in a single subject or 30 hours in three related subject areas; educational psychology; and child growth and development.

The UCITE program for the Professional Senior Year is based on the following major goals:

1) To provide more opportunities for prospective teachers to work with children;

2) To provide for immediate application of skills and knowledge gained in education courses;

3) To expose prospective teachers to various organizational patterns in schools;

4) To interrelate the various methods which previously had been taught separately;

5) To provide for continuous evaluation of and change in the program;

6) To individualize and personalize the media of instruction.*

The fall semester begins by having the students spend the first week in a local public school. They work with the teachers before the children begin school. They become involved in the public school's pre-semester teacher orientations and preparations for classroom activities and are there when the children begin school. After the first week, they spend a half day every day as an Instructional Assistant in a public school and the other half day working in the methods laboratories on campus. After a period of approximately seven weeks, the students have a full week to visit other schools in the immediate area or the state. Following this visitation they return to their I.A. experience switching A.M. and P.M. assignments so they have opportunity to work with children in both morning and afternoon classroom activities.

> The fall semester of the Professional Senior Year consists of a series of self-paced, individualized and personalized experiences centered in campus learning laboratories and in the classrooms of the public schools of the area. One-half of the prospective teacher's time is spent on campus and one-half in the public school environment.
>
> During campus laboratory experiences in language arts, mathematics, media, reading, science, and social studies, each student tests himself. Areas in which he is competent he will by-pass; areas in which he is weak he will practice; areas in which he has interest he will pursue. There are no traditionally organized classes. The amount of time spent in any laboratory is determined by each student's competency and/or interest in the area. Learning experiences may be individual, small group, or large group and may occur on or off campus, in or out doors. There are certain skills or techniques in which levels of competency are judged to be crucial. The student must attain these levels by demonstrating his competency in the campus laboratory and/or school setting.*

*From student orientation handbook.

Each campus laboratory has a set of modules designed to familiarize the student with content and methods of teaching the subject matter to children. As an example, the modules in elementary mathematics education follow this basic format: behavioral objectives and a rationale are given; materials needed for the laboratory or in-school activities are listed; the student completes the pre-assessment and checks himself to see if he understands the material covered in the module; a development packet is included to give developmental background and information for the topic at hand; an activities packet is included suggesting activities to perform in the laboratory and/or with elementary children in their I.A. experience; and finally, a postassessment is included to check his knowledge of the module at the completion of all activities he chooses to employ.

The university professor or his teaching associate(s) are available to assist individuals or small groups in the math. lab. If he feels several students are having the same problems or misunderstandings, he may schedule a group discussion on that topic. Or, there are times when he schedules a lecture on a particular topic to give added emphasis or other suggestions that cannot be included in the modules. Demonstration lessons have been conducted by the professor with classes or groups of children in a local school so the university student can observe a particular approach to teaching given concepts or skills.

One of the major advantages in this approach is that the student is able to practice immediately in a live classroom situation the things he learns in his methods laboratories.

In the spring semester, the students are subjected to a week of orientation to student teaching and social foundations of education. These sessions include presentations on perceptions of learning needs, teacher behavior and student learning, student behavior, race and minority problems, and teacher placement. This is followed by a full-day eight weeks student teaching assignment in a local classroom (one student to a room). After the student teaching assignment, the students come back to the campus for a week and one-half of further discussions on social foundations in education, philosophy, and school organization. The final experience in the spring semester is a six weeks differentiated assignment. If the student had a successful student teaching experience, he is allowed to elect an experience with children which could include one of the following types: continuation of the previous assignment, move from open-space school to self-contained classroom, from urban to inner-city or rural areas, departmentalized school, school camp, private or parochial school, work with a special teacher (music, art, physical education, remedial reading, etc.) special education, work with a social worker, librarian, wards of the court, and any other experience they choose that involves working on an all-day schedule with elementary children.

This year we have 183 students involved in this program on the Boulder campus and 72 on the Denver Center campus. Each laboratory has had one methods professor and at least one half-time doctoral candidate to keep the labs open from 8:00-5:00 daily and two evenings during the week. In addition the program has a fully equipped power shop called the curriculum materials laboratory with a shop

supervisor where students and teachers in the area may come to make classroom teaching devices. All materials and equipment are provided through the students' enrollment fees and materials are provided without cost to classroom teacher through a grant from the NSF.

Students in elementary education initially are admitted to the UCITE program by a screening committee. They are evaluated periodically for retention in the program. Another facet of the program is a personal assessment phase which apprises the student of his strengths and weaknessess in basic personality factors, attitudes toward children and teaching, and ability to perform teaching tasks. The personal assessment phase is comprised of a battery of tests emanating from the University of Texas R and D Center.

For physical facilities, we began this program with office space, a mathematics-science laboratory, a media laboratory, a social science laboratory, a reading-language arts laboratory, an open classroom, shop, four small group discussion and/or viewing rooms, and three storage rooms. The program has been assimilated into an UPSTEP-NSF project from which some funds have been received for equipment and teaching associates.

The flexibility of the program has been one of its major advantages. Another has been the interpersonal relationships that have been provided in the labs through students abilities to work with each other, a teaching associate, or a professor on a one-to-one or one-to small group basis. Rapport between faculty and students has never been better. This may be the result of several other factors such as no letter grades (all grades are pass or no-pass), no regularly scheduled lecture sessions, and freedom to come and go from each lab as the student feels the need.

The time involvement for each professor has been significantly more demanding than in a traditional program, but the experience has been much more rewarding.

The program is under the constant surveillance of a monitoring committee. Baseline data have been compiled on our "old program" and are being incorporated in a doctoral thesis and will be available sometime after the summer of 1972.

A program with such drastic changes as we have effected here with its departure from the traditional lecture approach naturally presents many research opportunities. These would include such things as screening, attitudes, application of subject matter to instructional situations, value of this approach versus traditional as it applies to the student teacher's performance in open-space achools, self-contained classrooms, inner city, rural, etc.

Minor changes are anticipated for the continuation of this program next year. Student attitudes toward it are tremendously complimentary and the local schools seem enthused about its effectiveness in training teachers.

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THE INDIVIDUALIZED INSTRUCTION PROJECT FOR STUDENTS ENROLLED IN EL. 313 THE TEACHING OF MATHEMATICS IN THE ELEMENTARY SCHOOLS

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Each semester approximately 200 elementary education majors in the undergraduate methods course The Teaching of Mathematics in the Elementary Schools at Indiana University of Pennsylvania. These students are usually sophomores having completed at least six credit hours of mathematics roughly paralleling the content suggested by the Level One C.U. P.M. courses developing the real numbers plus some informal geometry and probability. However, the students have not had student teaching experience at this point which may or not be an advantage for influencing attitudes related to the teaching of mathematics to elementary school children. Since the members of the Mathematics Department at Indiana who teach the methods course do not serve in an official advising role during the students' student teaching experience (this is done by members of the Elementary Education Department), we felt that students completing the methods course should be able to interpret and/or construct behavioral objectives appropriate to the content being taught, select or design appropriate teaching strategies and materials to achieve these objectives and have some actual experience practicing and evaluating these skills with elementary school children.

We were fortunate in having a Campus Laboratory School (The Davis University School) which had begun using the Individually Prescribed Instruction materials in mathematics (developed by The Learning Research and Development Center at the University of Pittsburgh) in September of 1969, one year prior to the initiation of this project. Here was an excellent opportunity to acquaint our elementary education majors with an individualized instruction program with the following features:

(1) The rate of speed at which each child progresses depends upon his own capacities. He places himself on the continuum by taking both placement tests and pre-tests.
(2) The curriculum material is arranged in a sequential order of behavioral objectives called a continuum. The assignments are given by a prescription to fit his individual needs. (A prescription is an individual lesson plan for each student each day.)
(3) The student's mastery of the curriculum is judged by curriculum-embedded tests and post-tests. He is required to perform at a level of 85%.

(4) The child works independently in most cases, thus building up his sense of responsibility and also his confidence in his own knowledge. He begins to realize that learning is a process that is dependent on his own participation and initiative.

The basic mode of instruction in the I.P.I. program is programmed instruction. Provision is made to supplement or enrich this mode of instruction with methods and materials or the classroom teacher's experience. Why not let our students serve as individual tutors and resource people for children needing instruction beyond the programmed I.P.I. materials? After consultations with the principal and staff of the University School we arranged to have each student in El. 313 assigned to an elementary school child in grades K-6 at the University School for three hours on days spaced closely together as the schedules of the college student, cooperating teacher at the University School, and the elementary school child would allow. Also, the college students were given the opportunity to request the type experience they would prefer (Kindergarten, primary or intermediate) and the time of the semester that they preferred to have their visits at the University School. In most cases we were able to honor their requests. The experiences and activities that were to be engaged in during these visits were henceforth dubbed The Individualized Instruction Project.

Before the students began their experiences at the University School, it was necessary that they become acquainted with the Individually Prescribed Instruction program, its assumptions and its evaluative techniques. To facilitate this background lectures and readings in constructing learning hierarchies, writing behavioral objectives and theories of intellectual development were provided and discussed in class. Also, Dr. Alvin Stuart, Director of the University School, presented an illustrated lecture on the I.P.I. program and how it was administered at the University School.

The activities that the college students were to engage in during their assigned visits to the University School were described in a hand-out given to the students. Here is an excerpt from this hand-out:

"During your first classroom visit at the Primary and Intermediate levels you will be able to examine the student's folder which will include test results of the current unit of work that your student is working on. The student may be taking a "pre" or "post-test" on a unit. If he is taking a pre or post-test you may observe his work but under no circumstances assist him in taking the test. From the information in the child's folder and your observations of his current work, try to assess the strengths and weaknesses of the student in this unit of work. You should then plan activities to help or enrich his understanding for the following visits. Whenever possible, provide some objective means of evaluating your efforts.

Kindergarten experiences will consist mostly of observing and assessing stages of concept development by using materials such as

matching sets, counting cubes, attribute and logical blocks, cuisenaire rods, creature cards, people pieces, play dough and perhaps sand or colored water. (See "How Children Form Mathematical Concepts," by Jean Piaget at reserve desk in the main library.)

You will be expected to mainly observe activities during your first visit and then be ready for individual instruction during your remaining visits. Keep a day by day "log" of your experiences including: (1) Your diagnosis of the student's strengths and weaknesses based on your observations and information in the child's individual folder, (2) A lesson plan for your teaching (list behavioral objectives when possible and activities and materials used to achieve these objectives), (3) Your personal evaluation of the success of your activities, (4) A list of any references consulted in planning your activities.

Don't hesitate to consult your university instructor for help in finding materials for your activities. The teachers at the University School will be a source (time permitting), also. The write-up of your experience is due one week after your final visit."

Although no formal statistical studies to measure cognitive and/or affective changes in the students completing the project have been attempted we have been generally gratified by the experiences reported by the students in their post-experience write-ups and the comments of the teachers at the University School. Our students have generally rated this experience as one of their most valuable experiences gained in the methods course. The teachers at the University School have been very cooperative in assigning our students to children needing help in various areas of mathematics and they have had general praise for the project from the standpoint of their elementary school students as well as our college students.

I personally (the other instructors of the methods course have indicated similar reactions) have noticed the students making frequent use of the manipulative and other resource materials that we have in our Curriculum Laboratory in their individual tutoring. They have seemed much more skillful at writing and using behavioral objectives as a means of organizing their teaching strategies as a result of having to actually use these strategies in their tutoring. Finally, they have brought their actual experiences in teaching elementary school children back to the classroom for class and individual discussions which was not possible prior to the initiation of the Individualized Instruction Project.

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UNDERGRADUATE SEMINAR FOR PRE-SERVICE ELEMENTARY TEACHERS

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The Department of Mathematics at the University of Northern Iowa offers two seminars which students may elect to take either before or after their 9-week student teaching experience. These seminars are offered for 9 weeks and carry 1 semester hour of credit. The prerequisite for both of these seminars is two content courses in mathematics and a course in the teaching of elementary school mathematics. One seminar concerns methods of teaching mathematics to the slow learner, while the other is a laboratory and activity oriented approach to the teaching of mathematics.

Participants in the seminar which concentrates on the slow learner identify those students who are slow learners in math in a specific grade in one of our Cedar Falls-Waterloo elementary schools. The participants develop a daily tutoring program for their pupils and work with them individually and in small groups. They develop and make teaching materials and aids to help them in their tutoring sessions.

Participants in the lab-activity oriented seminar write activity cards, write lab-type problems and make accompanying materials which are necessary, collect and make game-type activities, collect and write enrichment, and drill activities. Each student will work with a teacher in the public schools in the area and teach some math classes which use some of the materials which the participant has prepared.

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CURRICULUM COURSE IN MATHEMATICS EDUCATION

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The author had been dissatisfied with a number of aspects of one of the mathematics curriculum courses. The lecture approach was not appropriate in that practice was not being made of expected procedures which students were to exhibit in their own teaching. Evaluation of students was based on a few major term papers, oral reports, and mid-term and final examinations. The large supply of teaching aids in the curriculum laboratory was not being effectively used. There was no opportunity to communicate with children.

The rationale for an innovative approach to this course was based on two main purposes of the course:

A. To promote the idea that curricular topics in mathematics can provide the medium for a meaningful and enjoyable communication among children and adults,
B. To examine elements of a curriculum in elementary school mathematics by:
   1. becoming aware of new teaching materials (concrete aids, printed enrichment, films, kits and games)
   2. giving consideration to mathematical topics which are supportive, complementary or supplementary to the basic curriculum.

This one semester course is compulsory for all students on our elementary mathematics specialization pattern. Pre-requisites for the course are as follows:

A. College algebra (2 semesters),
B. College geometry (2 semesters),
C. Choice of 2 semesters of other mathematics courses,
D. Curriculum and instruction in elementary mathematics (1 semester),
E. Instruction in elementary mathematics (1 semester)

The students are usually in their last year of a four-year Bachelor of Education program. The enrollment in the course is usually 25 or 30 students.

The usual topics in a curriculum course (pre-number, number, numeration, operations, geometry and measurement) are dealt with in a laboratory situation. These topics are presented in accordance with purpose 2(b), since students have received basic coverage of the content in pre-requisite courses.

Instead of oral presentations by students to the whole class, small group sessions are planned as follows:

A. Each person will be required to plan two 20 minute presentations in which some activities from the mathematics curriculum are introduced to a group of 4 to 9 classmates.
B. At any one time, four presentations will be scheduled. Each person responsible for a presentation is requested to post a sheet briefly describing the topic to be presented. Class members will be able to attend one of every four sessions, according to the topic or grade level of interest.
C. In planning a presentation, attempt to cover only a small specific and interesting portion rather than an overview of a large set of ideas. Plan to spend a minimum of time on explanation; instead, plan activities utilizing concrete aids, games, activity sheets in order to foster group participation. Encourage informal discussion relating to the use of the featured idea or materials in the classroom.

Students are asked to consider one topic from each of the following lists of materials presently available in our curriculum laboratory:

A. Games and Kits
1. Action Fractions - Squares, Triangles (Math-Media)
2. Adding to 100 - (Moyer-Vilas)
3. Addition - Orbiting the Earth (Scott-Foresman)
57. Yahtzee (Math-Media)

B. Books and Series
1. Allen, Chuck Daily Chores (Creative)
2. Andrews, W.S. Magic Squares and Cubes (Dover)
3. Bates, W.W. Mathaction (series) (Copp-Clark)
54. Westcott, A.M. Fun With Timothy Triangle (Oddo)

The field experience component for this course is limited to the teaching of mathematics. Students have had field experiences covering all subject areas in each of their three previous years. Each of the students is assigned to a particular classroom for one mathematics period a week for an eight week period. The student is expected to prepare materials and present lessons to small groups of pupils or to the whole class. So that benefits might be shared by both the student and the classroom teacher (as well as the pupils, of course), the following format is proposed:

A. Teacher describes topics presently under study or topics which have been studied and for which a need is seen for interesting drill and practice material. Student prepares and presents this material for one half the time of any visit.
B. Student describes a topic which he would like to try with a group of children. The material may or may not be directly related to the topic presently under study in the class. Teacher gives student permission to present such material in the remaining time of the visit.

It is important to note that an attempt is made to promote a peer relationship between student and teacher in that the student usually has a better mathematics background while the teacher has the advantage of experience.

A final innovative aspect of this course is the contract for evaluation. University regulations demand a final grade for each student based on the stanine system. Previous practice was to grade every field experience, oral and written presentation with a grade from 1 to 9. The entire contract consists of three parts: leadership of small group sessions, participation in field experiences, and submission of written assignments.

The first two parts are basic in that each person is expected to make two small group presentations and eight school visits. In special circumstances, a person may do an extra written assignment in place of two school visits. The written assignments are done on the basis of one assignment for each stanine level above 2 (e.g., for a stanine of 7 to 5 assignments plus the small group sessions and the school visits). Assignments will be graded as follows - exceptional, acceptable and re-work. For every two exceptional assignments done, the total number of required assignments for a particular stanine level is reduced by 1. The latest acceptable date for assignments to be graded and returned for revision is three weeks before the end of classes. Assignments may be turned in without opportunity for revision up until the last week of classes. Topics may be chosen from the following list or on consultation with the instructor:

A. Comparison of the British-Canadian, activity-oriented book "Freedom to Learn" (Biggs and MacLean) with the American book "The Laboratory Approach to Mathematics" (Kidd).
B. Comparison of the coverage of pre-number concepts in two of the following kits:
   1. Learning Logic, Logical Games (Dienes) and Logical Blocks kit
   2. Developing Number Experiences Kit A (Neufeld)
   3. Attribute Games and Problems (Elementary Science Study)
N. Compare three separate issues of The Arithmetic Teacher, one chosen from each of the 1954-56, 1962-64, 1969-71 periods to indicate curricular trends over the past 18 years.

Evaluation of this program to date is based only on the enthusiasm of the students in comparison to student reaction to previous offerings of this course. Research is being planned to evaluate the use of teaching aids in the first year of teaching by students who have taken this course. It is hypothesized that students who have been introduced to a number of teaching aids not only will use more of these aids in their first year of teaching, but that they will be more likely to design their own aids according to particular needs.

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AN EMERGING MATHEMATICS EDUCATION PROGRAM

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Miami University is contributing to the improvement of elementary school mathematics by means of coordinated, mutually reinforcing innovations in (1) the content and methodology of elementary school mathematics, (2) the pre-service mathematics education of prospective teachers, and (3) the re-orientation of in-service instructional personnel.

Factors Precipitating Program Innovation

1. Evidence had been accumulating from replication and extension of Piaget's observation of children, that discrepancies have long existed between the way children learn mathematics and the way mathematics educators have advocated that they be taught. Instructional theory, techniques, and materials needed to be developed, consistent with the way children learn.

2. Dissatisfaction existed with the type and quality of observation/participation associated with the mathematics methods course. Pre-service teachers were assigned to local school teachers for approximately 10 clock hours to observe and participate in mathematics instruction. This activity was not clinical in nature, there was little chance of relating it to theory, and it was often non-supportive and counter-productive to the course objectives. The procedure also played havoc with student schedules, requiring a free class period before and after the observation/participation hour for travel to and from the school location.

3. Dissatisfaction existed regarding the lack of articulation between the methods course and the subsequent student-teaching assignment. Rigid supervising teachers often destroyed prospective teachers' embryonic innovative philosophies initiated in the methods course.

4. Dissatisfaction existed regarding the nature and function of the William Holmes McGuffey Laboratory School, a private K-8 school operated by Miami University. McGuffey School was traditional in character, and as such did not serve as an exemplar or stimulator of innovation as might be expected of a university laboratory school. Its primary function was the provision of demonstrations of master teaching for passive observation by prospective teachers.

5. Two years ago, as part of an overall reorganization of the School of Education, the University supervisors of student-teaching, the instructors of methods courses, and the classroom teachers of McGuffey School were consolidated to form a new Department of Teacher Education. This consolidation resulted in a new cooperation, a greater articulation among the hitherto separate areas of theory,

observation, and student-teaching, and an esprit de corps among the faculty.

Assumptions Undergirding Program Innovation

1. Although S-R learning theory provides an adequate model for skill development, developmental learning theory provides a re appropriate model for facilitating concept construction.

2. Traditional scope and sequence systems need to be revised in light of accumulating knowledge regarding concept construction in children.

3. The individualized, manipulative, child-centered instructional strategy known as the mathematics laboratory approach should be further refined and utilized in elementary school mathematics education.

4. If future teachers are to initiate mathematics laboratory instruction in their classrooms, they must be assisted in perceiving this approach as a legitimate means of instruction. Since most of their experiences as learners has conditioned them to teacher-dominated, symbolic instruction, they need to experience learning by this mode of instruction.

5. The competencies developed in a teacher education program should not be restricted merely to the understanding of theories and materials, but should be extended to include skill in utilizing these theories and materials with children and in developing professional behaviors. This development should not be fragmented with understanding of theories and materials relegated to a methods course and practical skills and professional behaviors assigned to student-teaching, but rather it should be integrated in a spiral approach throughout the four-year program.

6. The progress of the prospective teacher should be evaluated in terms of all the competencies above.

7. The nature of student-teaching with its total emersion of the prospective teacher into the complex operation of a school is so overwhelmingly impressive, that it establishes many permanent attitudes and operational modes that supercede those developed earlier. In order for student-teaching to support and reinforce the objectives of the overall program, student-teachers must be placed in carefully selected environments in which the school staff is working cooperatively with the teacher education faculty toward the same objectives.

8. Pre-service teacher education can be a significant, but indirect, means of in-service teacher education, since many supervising teachers look to their student-teachers as a source of up-to-date ideas and practices.

9. Whether it be the Hawthorne Effect or the result of ego-involvement, a dynamic atmosphere of excitement is created among persons engaged cooperatively in an innovative project aimed at doing something better than it has been done before. Therefore it is desirable to create an environment in which pre-service and in-service teachers are made to feel that they are an integral part of a differentiated staff that is pioneering the development of materials and techniques, and that is learning together.

Description of the Emerging Program

At a time when many university laboratory schools are being discontinued, a revitalization of the McGuffey School has served as the focal point for all aspects of the emerging mathematics program.

Beginning in the spring of 1970 one of the mathematics methods course instructors became deeply involved in the development of mathematics laboratory materials and techniques. This involvement took the form of teaching children in the summer school programs during the past two years and of part-time teaching and consulting with the regular classroom teachers during the past two academic years.

During the 1970-71 academic year the three primary grades were reorganized as a non-graded unit. The 95 children were separated into two groups for mathematics which alternated on different days of the week between group classroom instruction and laboratory activities in a connecting multi-purpose room. Commercial materials were collected, many materials were developed, and several techniques were developed for dealing with problems of class management, evaluation of learning, record-keeping, logistics, and storage. During the 1971-72 academic year the laboratory program has been extended to the 9 and 10 year-old classes, and work is continuing on the development of instructional materials and techniques.

The activities of the pre-student-teaching, mathematics methods course have become so closely correlated with the McGuffey School mathematics program, that some aspects are difficult to classify as to whether they are primarily teacher education or curriculum development for the school. This is due to the fact that students in the course work on real curricular and instructional problems of the school. The course carries 4 credit-hours under a quarter system and has an enrollment limit of 70 students. The class is partitioned into two groups which alternate between a clinical participation two days each week and independent study with auto-instructional materials on two other days. Once each week all students meet together for a 2-hour lecture on instructional theory and procedures. Other activities include study of several textbooks on laboratory learning, and the preparation of a term project which typically is the production of learning materials designed by the student to embody the principles of laboratory instruction. Students are encouraged to develop prototypes of their materials, test their effectiveness with McGuffey School children, and subsequently revise them on the basis of that experience. The objective of this production activity is to provide the prospective teacher with experience and confidence to encourage him to continue this type of activity in both his student-teaching and during his future teaching assignments.

The five classroom teachers who are working with the laboratory approach and their graduate teaching assistants have assumed responsibilities for assisting in the clinical activities of the students. About seven students are assigned to each teacher who has them conduct small group instruction or assist individual children working with laboratory materials. Each two weeks during the quarter the students are reassigned to a new teacher for experience with a new age-group.

While the students are working with the children, the methods instructor observes and evaluates their performance and professional behavior, and assists them in refining their instructional competencies.

The final grade for each student is based upon equal consideration of (1) professional qualities, (2) instructional competencies, (3) preparation of instructional materials, (4) understanding of instructional materials, and (5) understanding of instructional theory. Only the latter two items are measured by written examination. Students may also elect credit/no-credit enrollment. A rating scale with comments is used to record each student's performance during the quarter, and at the student's request this record may be used for recommendation purposes.

McGuffey School now serves as a demonstration school in which area school personnel can obtain ideas and assistance for initiating similar programs. The mathematics education faculty of the Department of Teacher Education also conducts an annual drive-in conference and an annual two-week summer workshop for the purpose of disseminating knowledge of materials and techniques gained through the McGuffey School mathematics laboratory program.

Current and Future Directions of the Program

Current expansion of this multi-directional approach to the improvement of mathematics education is being undertaken as a part of an Independently Guided Education (IGE) league being established by Miami University. IGE is an organization system developed by the Institute for Development of Educational Activities, an educational affiliate of the Charles F. Kettering Foundation. The Miami University League will initially include ten elementary schools cooperatively developing programs of individualized instruction, with McGuffey School serving as the intermediate agency. A special feature of this league will be the utilization of the league schools as student-teaching centers in which University faculty, classroom teachers, and student-teachers will work together in a mutually supportive context of instructional improvement.

Although actual developmental activities within the league are scheduled to begin in August, 1972, one of the mathematics education faculty members and the faculty of one of the league schools plan to begin the individualization of mathematics instruction this spring. Student-teachers, experienced in the McGuffey School program and assigned to this school, are expected to contribute significantly to this development.

It is the hope of the members of the Department of Teachers Education to work through the league setting toward the elimination of the existing dichotomy of methods courses and student-teaching, and create a unified activity in which prospective teachers will be able to develop theoretical understandings while concurrently acquiring increasing instructional competencies and responsibilities.

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A COMPETENCY-BASED APPROACH TO MATHEMATICS EDUCATION

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Many teacher education programs provide little or no opportunity for preservice teachers to show that they can, in fact, teach children. In addition, these programs usually emphasize exposure about teaching and require that a student attend class for a stated number of hours.

The program which is being developed at the University of Houston is achievement-oriented rather than time-oriented. This means that prospective teachers are required to show at least minimal teaching competence in order to exit the program regardless of the amount of time required. Sometimes a teacher can show competence within a month, or a semester, or a year. What is important is that teachers demonstrate the attitudes, skills, understandings and behaviors (competencies) which are needed to facilitate interactions between pupils and mathematics. This thrust by mathematics educators is part of a college-wide endeavor to move toward competency-based teacher education. We believe that it is important to see a preservice teacher actually show his teaching ability. Our whole program is designed to provide opportunities for the students to meet this goal.

Let it be emphasized that this program is still in the developmental stages. Our objectives are under constant scrutiny by faculty members and students. Those goals which are beneficial are retained and those which are not are discarded. Feedback from preservice teachers has been very helpful in giving direction to our development activities.

At the present time, all elementary education majors must take a course, Mathematics in the Elementary School. The competency-based approach is being used in this course which enrolls approximately 175-200 students each semester. These people are usually juniors and seniors.

Mathematics education faculty and graduate students designed this approach. Both groups work with public school teachers and principals to carry out the program.

Materials utilized in this approach include: modules (described below) and slide-tape presentations which were developed by the mathematics education faculty, suggested mathematics

methods textbooks which students purchase, selected library references including mathematics texts for children, materials for teaching in the mathematics laboratory, and films.

Facilities include public school classrooms, the Learning Resources Center (for audio-visual media) and the mathematics laboratory located in the College of Education, the University library, and classrooms on campus.

The content of this program is organized in modular fashion in the areas of planning, teaching, and evaluating elementary school mathematics; diagnosis of pupil difficulties; individualed approaches for use with children--mathematics laboratories and single concept modules which are constructed, used with children and evaluated by preservice teachers.

A module consists of a rationale, behaviorally stated objectives, preassessment procedures (in some cases, this is an area in which we are presently developing materials), learning alternatives for enabling students to meet objectives, and evaluation procedures. The objectives feature explicitly stated criteria for assessing competencies. Criteria include these four types: (a) cognitive criteria for assessing knowledge and intellectual skills; (b) performance criteria, for teaching behaviors; (c) consequence criteria, for effectiveness in terms of pupil growth; and (d) exploratory criteria, for open-ended experiences which teacher education students should have.

Insofar as possible, there are several alternative ways by which an objective may be met. These activities may include seminars, selected reading materials or various mediated presentations. One alternative in each set of activities is "student option." This is included to allow an individual to structure his own learning situations. Regardless of which alternative the student selects, he is expected to meet the criteria stated in the objective. Should he fail in the initial attempt, he is recycled through other learning activities until he does meet minimal criteria. Individual and small group conferences between instructors and students are a necessity in this program. Often students offer suggestions which give instructors new insights regarding objectives and enabling procedures.

Preservice teachers also work with pupils in local public elementary schools. They work with small groups of children; groups vary in size and ability level. Under these conditions teachers-in-training can field-test materials which they develop and can see first-hand whether or not children can meet objectives in the mathematics lessons they plan and teach.

To date we have surveyed informally many of the participants in the program, regarding strengths and weaknesses. We have used this feedback in restructuring certain objectives and learning alternatives which were vague.

Responses from student-participants in the program have been generally positive. A few prospective teachers still prefer a highly-structured teaching-learning situation. By and large, however, teachers-in-training seem to appreciate the opportunity to work with elementary school pupils and to have a voice in

what they are expected to do. Public school teachers are quite enthusiastic about having the university students in their classrooms.

Mathematics education faculty realize that this program is still in its developmental stages. We are quite enthusiastic, however, because our initial experiences indicate that a competency-based program seems to place the emphasis where it is needed most. We also expect to begin collecting data regarding its effectiveness in a more systematic manner in the very near future.

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ELEMENTARY EDUCATION JUNIOR PROJECT AT OHIO UNIVERSITY

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Work with children is a desirable component of teacher education programs for many reasons. The ones upon which this project was based were:

(1) Work with children facilitates college student self-selection and -retention in teacher education,

(2) Work with children enhances the college student's feelings of program relevancy, and

(3) Work with children enables teacher educators to evaluate attainment of specified teaching competencies.

With the preceding in mind, several members of the Elementary Education faculty of Ohio University designed a program for elementary education majors which involves extensive work with children in content areas concurrent with methods courses. The project is of two quarters duration and carries 30 quarter hours of credit so that the student's full-time load is with the project.

Sophomore students volunteer for participation. The project is in its second year and has involved approximately 30 students (one class or section) each year. During this past Fall Quarter students enrolled for the following credits:

6 q.h. -- Reading and Language Arts Methods
4 q.h. -- Mathematics Methods
2 q.h. -- Field Experience (observation)
3 q.h. -- Independent Study

The reading and language arts met two two-hour sessions each week; the mathematics met one two-and-one-half hour session each week plus 50 minute testing sessions as needed, and the only other class was a one-and-one-half hour seminar each week on project details, field trips and general topics of instruction.

During the Winter Quarter, the following schedule was followed:

4 q.h. -- Science Methods
4 q.h. -- Social Studies Methods
3 q.h. -- Advanced Studies of Children
4 q.h. -- Independent Study

The daily schedule for the Fall Quarter was:

Monday:	AM -- Schools (8:15 - 11:30)
	PM -- 2 hr. Reading/Language Arts
Tuesday:	All Day -- Schools (8:15 - 3:00)
Wednesday:	AM -- Schools
	PM -- General Seminar
Thursday	AM -- Free
	PM -- Reading/Language Arts (and Math. tests as needed)
Friday	AM -- Mathematics
	PM -- Free

Groups of 2 or 3 college students worked with one teacher at a grade level of their choice. The classroom experiences were limited to mathematics and reading/language arts during the Fall Quarter. They worked with individuals and small groups. Class instruction was an experience reserved for student teaching.

A staff equivalent of 1-1/3 and a graduate assistant was used for the 15 quarter hours (R/LA -- 1/2 time; Math. Ed. -- 1/3 time; coordinator and general seminar -- 1/2 time). Students provided their own transportation and all classes were held on campus. Students were working in two elementary schools and course instructors usually visited one school for a half day each week.

The mathematics methods work was divided into three types of criteria: Product Criteria, Demonstration Criteria and Testing Criteria.

Product Criteria are those which are met by creating a product which is presented to the instructor for evaluation at his leisure. These are the Product Criteria utilized:

I. Lesson Plans
   - A. Individual, small group, class; review or practice, guided discovery, pure discovery.
   - B. One page statement relating a grade level topic to the work of the previous and succeeding years.
   - C. Sketch sequence of five lessons using teacher's manual.

II. Evaluation and Prescription
   - A. Construct clinical and analytical tests
   - B. Summary of results and prescription.
   - C. Analyze a standardized test.

III. Presentation
   - A. Construct audio-visual aid, discovery materials, unipac.
   - B. Bulletin board which develops a concept, critique use.
   - C. Submit activities for pure discovery, guided discovery, practice, quest or enrichment, integration with other subjects in the curriculum.

Demonstration Criteria are those which are met by carrying out an activity which is observed. The Instructional Materials are demonstrated in a lab operated by graduate students as an optional course project at the masters level. Here is the list utilized:

I. Teaching
   A. Lessons: review or practice, guided discovery, pure discovery, single child, small group.
   B. Special materials and techniques: single child, small group, audio-visual aids, "every pupil response" techniques, unipac.
   C. Tutor a child for two weeks (6 sessions) as a follow-up to clinical diagnosis.

II. Evaluation
   A. Teacher-made tests, clinical and analytical diagnosis.
   B. Standardized tests.

III. Instructional Materials
   A. Number line
   B. Cuisenaire Rods
   C. Place Value Chart
   D. Abacus
   E. Attribute Blocks
   F. Counters
   G. Geoboard
   H. Geometric Models
   I. Flannel Board
   J. Dienes Blocks
   K. Hundred Chart
   L. Fraction Kit

Each student was given handouts with more detailed explanations and specific criteria for each item.

The testing criteria were based primarily on the behavioral objectives in Underhill's text, Teaching Elementary School Mathematics by Charles E. Merrill (1972). There were six tests on the following topics:

1. Pre-operational concepts and numerations
2. Addition and subtraction of whole numbers
3. Multiplication and division of whole numbers
4. Measurement and Geometry
5. Development of addition and subtraction of rational numbers
6. Multiplication and division of rational numbers, decimals, and percentages.

Each test was administered twice so that a student could improve his performance. The programmed content-methods sections of the text made possible college student instruction without class time; this is what made possible work with children in K-6 simultaneously.

There were twenty-five product criteria and twenty-three demonstration criteria. Each was assigned a weight of one through ten with most having a value of 1 or 2. Weight was intended to equate with time required for completion. Some items such as diagnostic tests, tutoring and guided discovery could be repeated. Items could be completed in any order but procrastination was minimized through use of point-totals to be completed by specified dates. There were three grading options. Here is the information for a "B" in the course:

Letter grade B	Option 1	Option 2	Option 3
Demonstration Points	16	20	12
Product Points	30	35	25
Test Average (no F's)	B	C+	A

The three-page hand-out on criteria is available on request.

Nearly all the faculty and students who have worked with the project are enthusiastic about its impact. Relatively little evaluative data is available since the participants were volunteers, and the project is only being piloted at this time. Student response to the mathematics methods portion of the project was overwhelmingly positive as indicated by their written responses at the quarter's end.

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MICRO-TEACHING LESSONS: DIAGNOSIS AND MATH LAB APPROACH

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A one semester methods course in mathematics is taken by all preservice elementary teachers in the third year of a five year B.Ed. degree program. During this third year, successful completion of which qualified a student for a teaching certificate, nine weeks of student teaching are completed. Prerequisites include a full year (two semesters) mathematics course, usually "Fundamental Aspects of Mathematics for the Elementary Teacher."

In order to make topics treated in the methods course more meaningful for the prospective teachers, arrangements were made with a city school to allow the trainees to work directly with children at the school. In reality, the project grew out of a request in the fall of 1970 by a principal for faculty and student assistance. The project moved to another school the following year.

Micro-teaching Sessions

Diagnosis -- Teachers of grades 5 to 7 identified pupils considered to be working below their ability or grade level in mathematics. Two school classrooms were made available for the 25 trainees to work on a one-to-one basis with one of the pupils for a 45 minute period.

The first task was to determine the pupil's understanding of and skill in using operations and algorithms for whole numbers. Materials used in the diagnosis included a set of counters, a pocket chart constructed by the trainee, and a form with suggested questions and space for recording the pupil's responses.

Example 1 (Basic Division Facts) -- The trainee would ask the pupil for the answer to, say, $15 \div 3$ and record the response (correct answer, incorrect answer or no answer; answer given immediately or after some hesitation). The pupil would be asked to indicate how he obtained his answer and also to illustrate $15 \div 3$ divided into 3 equal groups, 5 sets of 3 in 15, and "I memorized it."

Example 2 (Subtraction Algorithm) -- The trainee would write the problem

$$\begin{array}{r} 345 \\ -\ 167 \\ \hline \end{array}$$

and ask the child to find the answer, and record his response. The pupil would then be asked to do the exercise using the pocket chart, i.e. remove from 3 hundreds, 4 tens and 5 ones; 1 hundred, 6 tens and 7 ones. Thus the child is forced to regroup and subtract at the concrete level. Reaction to the use of a pocket chart for this and previous exercises (place value, reading and writing numerals, addition algorithm) was varied. Many children had never seen the device used before. Some quickly caught on to the basic ideas and were able to use it to correctly answer questions they had previously been unable to cope with at a symbolic level. A few pupils apparently resisted using the aid, rejecting it as "too complicated."

The trainee summarized his finds in the following table:

	Add.	Sub.	Mult.	Div.
Understanding of operations				
Mastery of basic facts				
Understanding of algorithms				
Skill in using algorithms				

For a followup session each trainee was to choose, on the basis of his diagnosis, a concept or skill from among the topics tested, plan an appropriate lesson for the pupil, teach him the lesson, evaluate the results, and prepare a written report of the experience.

Math Lab Approach -- The purpose of this experience was to allow trainees to observe a setting in which pupils work in small groups on tasks suggested by assignment cards and involving the use of concrete materials and/or physical activity. Prior to going to the school to work with pupils, the trainees had two sessions on laboratory methods in which they discussed and saw a film on this approach, performed laboratory activities, and examined various activity programs and sets of task cards.

The teachers arranged for 25 groups of two or three pupils from grade 5, 6 or 7. Each trainee gave the task card he had prepared (dealing with a topic in measurement or geometry) to one of these groups and observed the reaction and progress of the pupils. He was encouraged to allow the pupils freedom to determine the nature of the problem or task and an approach to its solution.

Many trainees expressed surprise at both the pupils' lack of understanding of basic concepts and the amount of learning which seemed to occur in a short time. For example, one group of pupils became very excited upon discovering that the length of opposite sides of a table were equal and that one wouldn't need to measure all four sides to determine its perimeter.

Trainee reaction to both micro-teaching experiences was very favorable. Following the one-to-one diagnosis and instruction sessions, many students expressed the desire to return to the school to continue to work with their pupils over an extended period of time. The average student rating of the value of the two assignments was 4 on a 5 point scale.

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SECTION FIVE

PROMISING PRACTICES IN FIELD EXPERIENCES

ELEMENTARY TEACHER EDUCATION PROGRAMS

The seven papers in this section describe innovative arrangements with school districts which provide field experiences for pre-service elementary teachers. Although the programs include specific work in methodology, their primary emphasis is upon patterns of field experience.

TRANSLATING THEORY INTO PRACTICE

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For many years a major criticism of preservice undergraduate teacher education has been the lack of provision of extended systematic, supervised experiences with children prior to student teaching.

Efforts to provide such experiences too often fall short because they fail in some way to contribute to the educational programs of the schools in which the students are placed. This failure to contribute should not be a surprise because efforts of university personnel to provide practical experiences have been made from the standpoint of what the schools could do for them, rather than what they could do for the schools. And the schools do need help. The recent emphasis on individualization of instruction has left many teachers ill prepared. They need help in providing instruction geared towards individual differences. Colleges of education are as yet largely untapped reservoirs of inexperienced, but semi-skilled help. Upon this rationale, then, the following experience was based.

Participating students are enrolled in an elective elementary education course in methods of teaching elementary mathematics. These students have successfully completed a basic methods course in the same subject area, and are interviewed by the instructor before receiving permission to enter the course. The number enrolled is limited to 20.

Instruction and supervision of these students is by the instructor, two graduate students in mathematics education and cooperating teachers in grades 1-6. Support is also available through the Student Media Design Center which functions to help students prepare materials for lessons they have planned.

Apart from instructional time costs, no university money is spent since students supply their own transportation and pay for their own instructional materials.

Procedure: Prior to the beginning of each school term the following steps are taken:

a. Consultations with the principals of the schools involved to identify those teachers who will cooperate. Generally it is the same group of teachers.
b. Students are interviewed by the instructor and assigned to teachers on the basis of grade level preference, type of pupil they prefer to work with and compatibility with the cooperating teacher (a subjective judgment by the instructor). Some teachers may be assigned as many as three students or

as few as one.

c. Teachers complete a prepared questionnaire indicating to their assigned students the number and type of pupils they will work with, difficulties the pupils are having, their progress to date, an overview of the topics the students will be expected to cover, resources available, etc.

At the beginning of the school term the following procedure is followed:

d. Students meet as a group with the instructor for one week. They are assigned a cooperating graduate student who will be their resource person. They are also given the questionnaires previously completed by the teacher. This first week is spent discussing instructional strategies appropriate to the topics to be taught, identifying probable difficulties and possible solutions, and assembling or making suitable teaching aids.

e. For the next ten weeks the students spend one hour per day four days a week with a group of pupils which may vary in size from two to eight pupils. Each student is responsible for preassessment, development of suitable instructional strategies and evaluation of her assigned pupils. Generally, lesson plans are first prepared for and approved by the cooperating teacher.

f. Students are visited regularly (minimum twice per week) by the instructor and graduate student. Weekly conferences are held to discuss progress, make suggestions, etc. Course grades are given on the basis of these observations plus a written evaluation by the cooperating teacher.

This experience was not set up on an experimental basis. However, on a written questionnaire, teachers have reported that pupils show improved grades, increased participation in mathematics activities and have better attitudes to learning. The college students involved were enthusiastic about the opportunity to interact with children and to be responsible for planning and executing an instructional program. Another measure of success is that more teachers wish to cooperate than there are students available. All participants agree that the purpose of the experience is achieved The students get much needed experience with children in a real setting and the cooperating schools get much needed help.

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A PARA-PROFESSIONAL QUARTER

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In the academic year 1970-1972, Montana State University initiated what was for this institution a new program in the area of preparation of elementary teachers. This program, termed a Para-professional Quarter, consisted of placing junior students in Elementary Education in the elementary classrooms of the Bozeman Public Schools to work under the supervision of elementary classroom teachers while concurrently enrolled in professional preparation courses at the University. This experience was planned to precede the full quarter of student teaching, usually taken in the senior year.

As a preliminary to the present program, from two to six students per quarter worked in the Bozeman Public Schools as para-professionals during the academic years of 1968-1969 and 1969-1970, under the course classification of Education 470-Individual Problems. The experiences met by these students aided in the planning of the present program.

The goals and procedures for the Para-professional Quarter were worked out by a joint committee of representatives of Bozeman Public School teachers and administrators, all members of the M.S.U. Department of Elementary Education and one Montana State University student who had had previous experience as a para-professional worker.

There were two purposes for this program. First, it should provide the university student with valuable, practical experience with and knowledge about children and the teaching profession which could not be gained through purely academic coursework. Second, it was planned to provide substantial and valuable help to the classroom teacher.

The anticipated experiences and knowledge to be gained by the students were:

1. To learn as much as possible concerning conditions under which children learn best and how to organize and create a good learning atmosphere with a minimum amount of coercion.
2. To learn how children act and react under different stimuli.
3. To observe teachers' methods and techniqeus as they work with children.
4. To have an opportunity to practice teaching lessons to a small group of children in the subject fields of (1) reading, (2) mathematics, (3) social studies, and (4) language arts.

During the one and one-half years of total university involvement, approximately 175 students have participated in the program.

All junior-level students in elementary education at Montana State University and most students who return to the university for elementary certification following the completion of a degree in another field are required to participate in the program.

The program was structured in such a way that each student would be assigned to two different classrooms at different grade levels, with the time equally divided between the first and second halves of the quarter. Each teacher involved for a particular quarter would thus have a different student working with her for each half-quarter. This enabled each para-professional to observe and work with children of different age and grade levels, as well as providing them with the opportunity to see the various methods and techniques utilized by two different teachers.

The time schedule for the para-professionals included work in the public schools from 8:15 A.M. until 11:30 A.M., Monday through Thursday. They returned to the university campus for professional methods courses and seminars in the afternoon, Monday through Friday.

The para-professionals' responsibilities in the elementary classrooms included any duties in line with their development and training assigned by the classroom teachers or building administrators. In addition, they were encouraged to become sensitive to the needs of individual children and seek opportunities to enhance the over-all teaching climate. At some time during his Para-professional Quarter, each student was expected to teach a minimum of four lessons in each of the subject fields in which his afternoon professional coursework was preparing him. At least two of these presentations were to be observed and evaluated by a member of Montana State University's Department of Elementary Education.

An evaluation of each para-professional's work in the classroom is done at the end of each experience with each teacher. A comprehensive study of the program was undertaken at the end of the first full year of operation. The areas examined in this study were the attiudes of the participating college students and classroom teachers regarding the structure and operation of Para-professional Quarter after one full year of operation. The participants were asked to comment on the work performed by the para-professionals in the classroom, the coursework taken in conjunction with it, the organization of the academic and experimental parts of the program and, primarily, their personal reactions to various aspects of the para-professional experience.

The responses of the university students and the Bozeman, Montana teachers regarding the two major goals of the Para-professional Quarter, indicate that both students and teachers felt the program was a definite advantage to both the elementary teachers and the university teachers-in-training.

It has been the experience of the author that the Methods of Teaching Mathematics in the Elementary School course has been made much more relevant since the adoption of this program.

Students can communicate about real problems they are experiencing and have an opportunity to go to the schools to try out the ideas and suggestions made by their methods teachers and then communicate their results to the instructor and the rest of the class almost immediately.

A complete description of the program and an evaluation of the first year of the program is contained in an unpublished Master's degree professional paper by Virginia Britton.

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Q.E.D. MATHEMATICS STUDENT TEACHER PROGRAM

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This is a program involving student teachers from the University of Kansas, Kansas State University and the University of Missouri--Kansas City who are accepted by the Shawnee Mission Elementary Schools for the preservice experience. Appointments are scheduled by the university for the students they recommend for participation. The instrument of selection ranked the desire of the student teacher to participate--first, personality--second, and academic standing--third. From this list of college students, approximately thirty are chosen for each school year (five per university each semester).

Initially, all of these universities operated on an eight week assignment period. The Q.E.D. program existed for the first three weeks of this eight week period. During this time each student teacher was responsible for teaching sixty classes in mathematics. These classes ranged from Kindergarten through the sixth grade--approximately nine classes at each grade level. Opportunities to instruct at the seventh and eighth grade were also offered. All participants were responsible for designing, implementing and compiling the material for these lesson.

Problems necessitating this approach:

1. Transitional period between change from "traditional to modern" mathematics. Teacher inservice evidenced questionable value.
2. Student teachers' predilection for kindergarten and second grade assignments.
3. Poor attitudes toward mathematics.
4. A need to take inservice to the classroom and teacher NOT the classroom teacher to inservice.
5. The lack of enthusiasm toward mathematics in most elementary classrooms.
6. Teaching solely from textbooks (and a basic one, at that).

So, in an effort to ameliorate these problems the Q.E.D. Mathematics Student Teacher Program was originated in 1962. Articles describing the program in detail appeared in the May and November issues of the Arithmetic Teacher, 1965.* Periodic

*Titled, "Moot Mathematics."

feedback has dictated revisions since the initiation of the program. Although there is no panacea for the six listed problems, this program has cut deep inroads into them and created a multiplicity of serendipities.

On Monday, the first day of the preservice experience, all student teachers report to the mathematics coordinator. The morning is spent researching creative activities exploiting a selected topic in mathematics apropos for the elementary student. After tentative lesson plans are drafted for Kindergarten through the sixth grade, the remaining time is allocated to designing graphics and evaluation exercises to insure a presentation high in student participation and one which engenders a potential success for all.

A TYPICAL WEEK SCHEDULE

Monday -	
8:00 - 4:30	Planning and Preparation
Tuesday and Wednesday	
8:00 - 9:00	Report to mathematics coordinator at scheduled school, organize materials, assign classes (K-6), question/answer session.
9:00 - 9:30	Teach in a team of two. "A" teaches--"B" observes and helps with logistic problems (dissemination of materials).
9:30 -10:00	"B" teacher--"A" observes.
10:00 -10:20	Conference--alter lesson plans omitting parts evidencing low success level and adding ideas gleaned from students.
10:20 -10:50	"A" teaches--"B" observes.
10:50 -11:20	"B" teaches--"A" observes.
11:20 - 1:00	Conference and lunch. Continue alterations predicated by classroom experiences and observations. Move to another school for afternoon sessions.
1:00 - 1:30	A"A teaches--"B" observes.
1:30 - 2:00	"B" teacher--"A" observes.
2:00 - 2:20	Conference--again, alteration to concur with classroom indications.
2:20 - 2:50	"A" teaches--"B" observes.
2:50 - 3:20	"B" teaches--"A" observes.
3:20 - 4:30	Mathematics Resource Center--conference to refine existing lesson plan draft. Work on class assignment for different school for Wednesday.
Thursday	
8:00 - 4:30	Two different schools scheduled. Same time schedule except no team teaching. Each student teacher has sole responsibility for instruction in the eight classroom assignment period.
Friday	
8:00 - 4:30	All participants report to Mathematics Resource Center.

The lesson plans initiated on Monday have undergone extreme face-lifting during these days of reteaching and revising. On this day, the student teachers collaborate on one design which embodies an eclectic version of all the variations taught during the week. This version is mimeographed and copies are sent to all teachers and to over 400 schools across the nation. These lesson plans vehicle a bibliography and suggestions for follow up activities.

The materials used are multi-sourced--e.g., education projects, N.C.T.M., Dr. Bob Davis, Dr. Dienes, Madame Papy, Australian Educational Research Projects, Fletcher's Canadian project, Nuffield Project, Ontario Institute, Edith Biggs, Dave Page, etc., always avant garde with high potential for interest and participation.

During these three weeks these participants also accept assignments to speak at civic meetings, P.T.A., etc.

The program is self-financing, as all of the monies received on a pro rata basis from the universities are used for supplies and resource materials.

The 1972 spring session will involve 50 student teachers. Plans, at present, are to develop indepth lessions on some of the imaginative and creative ideas presented in "Donald Duck in Mathemagic Land." Recent compilations are: Dynamic Geometry; Soft Boxes for Hard Schools; Tangrams; Topology; Mathematics in Art, Music, Nature; Numeration Systems; Men in Mathematics (Newton, Galois, Napier, Fermat, Pascal, Descartes, Einstein, Boole, Galileo and Kepler); Probability; Mathemagic and Aestheometry.

The Education Department of the University of Kansas evaluated this program in 1967 and another evaluation appears in a doctoral thesis compiled in the fall of 1971.

The following effects have been evidenced from an eight year feedback. The effects of the program for the student teacher:

1. Familiarized them with avant garde material.
2. Tended to allay the fear of mathematics shared by most student teachers.
3. Increased the number of classroom teaching experiences and responsibilities.
4. Afforded an emphasis in a content area either for weakness or strength.
5. Increased the number professional evaluations as sixty different teachers observe each student teacher.
6. Offered self-evaluation from television experience (micro-teaching).

The effects of the program for the elementary student:

1. Exposed the students to materials which appear in other textbooks or projects.
2. Accented participation and created a learning environment reflected from indirect teaching techniques.
3. Introduced the kind of material which affords students more successful experiences.
4. Afforded an even start for students because the lessons are geared as initial presentations necessitating little formal background experience.

The effects of the program for the classroom teacher:

1. Presented a painless inservice while observing the presentation of materials slated for incorporation in future textbooks.
2. Allows the enthusiasm of the student teacher and the reflection of this enthusiasm on the students to be observed.
3. Afforded an opportunity of watching class function during the learning process.
4. Demonstrated increased student participation as a result of indirect teaching techniques.
5. Offered an opportunity for professional assistance to the emery-boarding of the student teacher. In fact, a degree of self-evaluation occurs in the process.

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THE PROFESSIONAL YEAR

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The Professional Year is a new program in preservice teacher education, elementary level, that was begun at the University of Cincinnati in September 1970. The general concept of this model for teacher preparation is neither new nor unique, but we know of no other program that is doing the same things in the same ways.

The Professional Year concentrates the upper-class professional courses and field experiences into three consecutive quarters of the junior or senior years. By this time, the students have had the required content courses in mathematics, history, science, English, psychology, and such. All the methods courses are given in the first two quarters of the Professional Year. The third quarter is devoted to student teaching. A part of student teaching is the so-called September experience which requires the student to spend the first two weeks of school in a classroom where he will participate later in the year; he sees how to get a school year started. Besides the methods courses, Children's Literature, a Media course, some Child Study, and Independent Study related to the work being done at the time are included in the first two quarters. Also, during these phases, the students spend twenty full days per quarter in blocks of a week at a time in an elementary school classroom participating in the daily activities of that classroom under the supervision of the classroom teacher and the staff of the Professional Year. Thus, when these students begin their student teaching, there is no panic; they have already had a gradual induction into the realities of public school life.

The Professional Year program started with a pilot group of about 30 students. A year and a half later, there were about 150 students (approximately the same number were enrolled in the alternative program).

Some of the principals of schools in which Professional Year students participated during the pilot year were very pleased with the program and suggested that its impact on the city schools might be bigger and better if just a few schools were saturated with Professional Year students, even including the possibility of holding university classes on public school premises. Arrangements were made for implementing their suggestions, and now we have little "universities" in two of the city schools with students participating in a total of six neighboring schools. During the

weeks the students are in university classes, they are in class all day each school day of the Cincinnati Public Schools calendar for the given week, with most of their instructors there most of the time. The general atmosphere is informal, and instruction cuts across subject matter boundaries, if such there be.

What we have done so far has involved no outside funding, and no expenditures beyond the standard budgets of the University and the City Schools. We are presently seeking outside funds for evaluating the program.

So far, there has been less trauma than some of us think we might have expected. We make it clear that the key word in this venture is WITH. Participation on the part of city teachers is voluntary. The general overall reaction has been favorable, and selected crucial reactions have been highly favorable. Of course, there are a few thorny spots.

There have been some questions about what real advantage comes from holding university classes on public school premises. Especially at first, many of our students complained loudly about being off campus. In a few weeks, most of them changed their tune, and we have had no further complaints about that. Some of the advantages are subtle. Many of them are impossible to delineate before the fact. They come from being there to seize whatever opportunity presents itself. We have anecdotal records ready for the eyes of anyone who wishes to see them. Among other things, during the current quarter some of the mathematics methods are presented via a group of twelve third graders taught by the university instructor with the Professional Year students observing the class and participating in the work with the children. Each class is preceded and followed by a discussion. We do different but roughly comparable things in other areas.

There have been questions, also, about what the city schools get out of this that they could not get equally well in some other way. Subjective evaluations by city administrators and supervisors have been highly positive, and we have extremely favorable feedback on the quality of our student teachers. The reports from participating teachers have been encouraging, and the perfect tribute came, perhaps, from the custodian at one of our schools:

> Instead of blasting us for cluttering up the hall with a dozen tables full of stuff, posters all over the walls, and things suspended from the ceiling for our Science Museum (exhibits prepared by sixth graders working one-one with university students) he asked whether he might contribute to it. And one day he said to our chairman, "I want you to know we're all glad you're here. It's good for the children, good for the teachers, and good for the rest of us. Even I have learned something from seeing things you do."

It must be recognized that, for both students and staff, the Professional Year is not for anyone who has a faint heart, or meager energy, or a pedestrian mind. The very nature of the program--dynamic, integrated across subject-matter lines, as contemporary as today--implies that no two quarters of any phase of the program will be the same. We are presently using a modified

version of team teaching in an open classroom with our university classes (people tend to teach in the way they have been taught) and we hope to involve in our program several more experts in other departments and colleges of the university, as well as more local teachers, and perhaps even a few parents of children in our field-service schools. Also, we'd like to get a few good minds at work on more relevant prerequisites for future classes.

The Professional Year differs from the alternative program at the University of Cincinnati, not in the sum of clock hours devoted to prescribed opportunities, but in organization, focus, physical setting for class work, quantity and quality of time instructors spend with students, and the character of the contribution made by the local public schools. Each week brings new plans, new dreams, new questions. Some of the questions are profound. For example: What is an effective and pleasant way to deal with the fact that, for most inner-city children, schoolroom English is truly a second language? How can we develop structure orientation in children whose out-of-school life apparently lacks organization of any kind?

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A DESCRIPTION OF A MODEL FOR THE PRE-SERVICE TRAINING OF TEACHERS IN ELEMENTARY SCHOOL MATHEMATICS

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In the past decade or so, many changes have taken place in mathematics programs on the elementary school level. As a result, teachers are expected to know much more subject matter and to be familiar with a greater variety of materials than was once expected of them. Moreover, there is a significant trend in education to individualize learning and to encourage the child to "discover" much of mathematics for himself. In order for such learning to take place, a new classroom environment must be established, one that stimulates thinking through a wide variety of problem solving situations and allows children to seek their own solutions. If future teachers are to be prepared to meet these challenges, then current pre-service programs in teacher education must be reorganized.

Traditionally, the training of prospective elementary school teachers has been in departments or schools of education, very much isolated from other academic disciplines and even from the public school system itself. The problem, however, of preparing these people to teach mathematics is too complex for any one segment of a university to handle alone. By involving both educators and mathematicians, both university professors and school teachers, more effective ways of initiating and coordinating their potential contributions may be found.

Accordingly, the mathematics component of the TTT Project in Elementary School Science and Mathematics at New York University has assembled an interdisciplinary staff to develop a model for preservice teacher education that reflects current theories and practices pertaining to elementary school mathematics. The staff includes one professor of mathematics education; two post-doctoral "Trainers of Teacher Trainers" (TTT); four graduate students in mathematics education, each an experienced teacher and each a potential "Teacher Trainer" (TT): and one pure mathematician.

Based upon experiences with both pre-service and in-service teachers during the fall semester, 1971, the project staff has developed an experimental model for preservice teacher education in elementary school mathematics. The essential substantive components of the model include: (1) a reorganization of the study of arithmetic; focusing on problem solving and discovery learning and (2) an extensive integration of subject matter and related

manipulative materials. In addition, the main structural components of the model include: (1) an interdisciplinary team-teaching approach to university-centered course work and (2) close coordination between university-centered course work and actual teaching experiences with children.

In the spring semester, 1972, the model will be pilot-tested on each of two sections of prospective elementary school teachers. Each section will contain approximately 20 college seniors, all of whom will be student teaching in New York City elementary schools. A team consisting of one TTT and two TTs will direct each section.

During the first ten weeks of the semester each section will meet at the university for one three-hour class period per week. In general, class discussions will begin by focusing on selected problems that children might reasonably confront in the real world. The emphasis will be on helping children to understand these problems by having them perform the actions therein and by counting the resulting collections of objects.

In order to prepare the prospective teacher to work with his own students in a context of exploration and discovery, he will be provided with many opportunities to develop his own personal "efficiencies" that may replace counting as a means of solving problems. Investigations of such efficiencies, including the standard arithmetic algorithms, will play an important role in class discussions.[1]

Manipulative materials that may be used to define or clarify a particular problem or to illustrate a particular efficiency will be integrated into the discussions whenever appropriate. Furthermore, the interdisciplinary team-teaching approach will allow for: (1) a number of small group discussions based upon the needs of individual prospective teachers and, (2) an in-depth exploration of selected materials.

In order to coordinate the university-based work with real life situations in New York City elementary schools, the TTs will personally supervise the prospective teachers in their day-to-day mathematics classes with children. (This supervision complements, but does not replace, the general supervision provided by the Department of Elementary Education.) Concomitantly, each TT will conduct a weekly mathematics laboratory for his student teachers so that they may gain facility in the use of materials.

During the last five weeks of the semester, the university-centered course work in teaching mathematics will be replaced by further involvement with children out in the schools. The prospective teachers will continue to develop and evaluate their lessons under the direction of the TTs, drawing upon the resources of the full project staff whenever needed.

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[1] A more complete statement of the philosophy guiding the approach to subject matter is contained in a separate paper by Dr. Robert Madell.

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PERFORMANCE-BASED, FIELD-ORIENTED TEACHER EDUCATION IN ELEMENTARY SCHOOL MATHEMATICS

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Responding to the needs of students to assimilate theoretical and experiential components of the teacher education program has been a continuing challenge to the College of Education at University of Washington. In the early fifties when elementary education became a part of the total program the issue was a pressing one, and in the mid-fifties special attention was given the mathematics segment of this program. However, except for observations, demonstrations, and some micro-teaching, the theoretical component appeared stronger than the practical or applied aspect of preparation other than student teaching. By the mid-sixties it was evident that a new unified approach to teacher preparation was essential, and with more precise specification of objectives in general, as well as in mathematics particularly, the College launched upon some experimental field-oriented, performance based programs in 1967. The development of these programs and the emergence of some new aspects are described more comprehensively than here in a publication to be released by AAACTE in the spring of 1972.

Initial efforts were concentrated on field-testing baseline designs for the establishment of (1) a performance-based, field-oriented conceptual model, (2) a cadre of clinical professors, (3) a field coordinator approach for the coordination of field and campus experiences, (4) an inservice education program for field associate teachers, (5) a temporary certificate for teacher interns during the final phase of field experience, (6) an intern selection procedure including the participation of school district personnel in the screening process, and (7) a coalition management model based on a steering committee approach to decision-making related to program development, conduct, and evaluation.

It should be observed, also, that the development of such programs was preparatory to a new type of teacher certification pattern in the State of Washington which emerged from several drafts as Guidelines and Standards for Development and Approval of Programs Leading to the Certification of School Professional Personnel, 1971.

General assumptions were as follows: (1) a professional program of study includes admission based on well-defined criteria, a predetermined enrollment, full-time commitment on part of student, integration of theory and practice, flexibility to accomodate diversity of personnel, cooperation of field and

campus in design, conduct, and evaluation of the enterprise: (2) principal agent and agencies have a role in decision-making; (3) it is imperative that teacher education does not become transformed from one historically closed system to another equally closed system. These assumptions generated a statement of some seventeen critical goals for specific programs.

For the mathematics component it was assumed further that (1) performance objectives could be generated which would serve as guides to program development and evaluation of participants; (2) there is congruence of theory and practice in mathematics educaiton; (3) associate teachers and interns as well as clinical staff need to be involved in decision making; (4) multiple resources and multi-media are required; (5) selection of content and materials need continuing re-evaluation in light of processes and products: (6) students have certain minimal competencies in mathematics and knowledge of learning theories; (7) there are some strategies of teaching common to mathematics, science, social studies. These assumptions have generated some new teaching materials and a flexible clinic type program of exciting potentials.

For the purposes of this paper the presentation from here on will focus on the clinic-type program of TEP/FO (Teacher Education Program/Field-Oriented), although the total program includes several variations at both elementary and secondary levels.

Organization. Approximately 40 students per quarter are selected by teams of interviewers from the school districts and College staff and assigned to designated associate teachers in elementary schools of cooperating school districts. Depending on the quarter of entry, groups are assigned to Clinic A or Clinic B. Clinic A focuses on Mathematics, Science and Social Studies; Clinic B, Language Arts, Reading, and Art. Students spend mornings in Clinic A first quarter, afternoons in the schools; second quarter, mornings in the school, afternoons in Clinic B; third quarter, upon receipt of temporary certification, full time in the classroom.

Associate teachers and clinical staff (professors and assistants) have continuing contacts through seminars and scheduled visits to observe interns in the school setting. Co-ordination of activities is facilitated by specially assigned school district personnel (coordinators) and University personnel. An expanded advisory committee has additional input and is the propotype of future consortia under the new state guidelines, the model for which enables local school districts and professional associations parity in the decision-making process with a college or university in teacher preparation and certification.

Resources. The TEP/FO clinic program was funded as part of the on-going regular teacher education program at the University. An open space equivalent to three classrooms was set aside for clinic use only, with new furniture, A-V and VTR, tapes, films and selected printed materials for staff and students.

Regular faculty were assigned in each instructional area, as well as teaching assistants with high qualifications in terms of both education and teaching experience.

Methods of Teaching. One or two sessions a week in the clinic are set aside for common concerns: methods of inquiry, ways of increasing pupil participation or individualization of instruction, problems of the inner city and cultural differences, utilization of community and regional resources, legal issues, professional associations, and contemporary professional issues. These are generally discussion sessions with films, visitors, and models.

At least one morning session a week is devoted exclusively to mathematics education. In these sessions a lab clinic situation usually prevails in which students are involved in activities related to objectives, exploration of innovative materials and practices, discussion of observations and experiences in the field, evaluation of teaching, and models of instructional strategies.

Curricular Content and Activities. Since students have at least 3 hours credit in a prerequisite mathematics course in the whole number system and logic it is assumed they have minimal competencies in this field; some may have had more mathematics. All are expected to take a competency test in mathematics which includes the rational numbers, geometry, measurement, and other selected topics. Students are given guidance for further study in areas of weakness.

Emphasis is on mathematics learning, with attention to diagnostic and evaluative processes. Early field assignments frequently are focused on helping individual children over a wide range of abilities. The statement, sequencing, and evaluation of objectives becomes pivotal in planning instruction.

Construction and evaluation of learning aids follows exploration and evaluation of innovative materials and study guides. Games and puzzles related to curricular objectives also have a place in clinic sessions, with focus on how they are used and the purposes they serve.

Since most of the cooperating school districts are committed to a continuous progress type program, individualizing or personalizing instruction and management of students working at different rates become major concerns. The intern is expected to develop a repertoire of strategies for concept development, guided discovery, exposition, drill and practice and also to develop criteria for selection of strategies. Ultimately the intern is expected to teach a sequence of lessons and to evaluate his own teaching.

Finally the student is expected to develop a repertoire of strategies for concept development, guided discovery, exposition, drill and practice and also to develop criteria for selection of strategies. Ultimately the intern is expected to teach a sequence of lessons and to evaluate his own teaching.

Finally the student is expected to synthesize ways of thinking about the learning of mathematics and demonstrate a broad range of teaching skills.

These units are prepared as packets with stated behavioral objectives, references, suggested activities, and check-outs.

Evaluation and Researchable Questions. Individual evaluations based on video tapes and observations are shared and recorded. For each student an initial and final tape are made in addition to other tapes and observations made by appointment to diagnose difficulties or develop strategies.

Continuing group evaluation of clinic activities is both formal and informal. The present program has been responsive to an extensive and intensive internal evaluation by staff and interns in the spring of 1971. Since this is a developmental program and populations are highly selected no comparative studies with regular classes have been undertaken. However, personal feedback and placement data indicate excellent reception by consumers.

There are many researchable questions associated with programs of the type described here. Presently variables are being identified and hypotheses formulated for testing. Graduate students in mathematics education should find this a fruitful field for investigations.

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AN OUTLINE FOR A COMPREHENSIVE PRE-SERVICE PROGRAM FOR THE PREPARATION OF ELEMENTARY SCHOOL TEACHERS

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A pre-service teacher education program is needed which reflects the changes that research and the profession have long been suggesting. Projects to date have not, in general, been broad enough nor bold enough in their attempts to accomplish the much needed reform. The program described below purports to do this. The principle structural change has the prospective teacher intern (with pay) in the latter two years of a five year program. Although inspired mostly by teacher preparation needs in the areas of mathematics and science, this program design also includes social studies, art, language arts, and interdisciplinary studies. This is based on the belief that preparation in no single discipline can be improved significantly unless all advance together.

For the first three years the prospective teacher attends college much like under the present system. Notable differences are: the exclusion of any "methods" courses or student teaching, and established minimum requirements in so-called content areas (at least six semester hours in each subject area). Finally, and not to be neglected, is exposure to young children through tutorial programs or out of class assignments in the elementary school.

Following these three years are two years of internship in an elementary school. The teacher candidate works with children, university personnel, his peers, and experienced elementary school teachers. The traditional notion of student teaching, with only brief contact with a supervising professor, is eliminated. The candidate is elevated to the status of paid intern and practices his future profession in the company of experienced educators. There is no salary loss for participating in the five year program because the intern is paid (pro-rated over the two years of internship) the equivalent of a first year's salary had he graduated in four years. The candidate benefits from an extended year of supervised training and professionally assisted analysis of his teaching performance. This follow-up, absent from present-day programs, is essential to the preparation of good teachers.

In the first year of internship, three afternoons a week are devoted to methods and materials courses. A fourth afternoon involves an analysis of teaching course. Application of this course work accounts for the remainder of the intern's time. The methods and materials courses are designed around combined subject areas (i.e. math-science). It is not expected that the separate subject areas be correlated into a unified curriculum. However, the results of the pairings (described below) will, at least, shed much light on procedures for correlating a given pair if it appears feasible and desirable to do so.

During the two years of internship, the candidate works as a member of a team. Included on his team are four instructors (representing each of the four year courses taken in the first year of internship) and a cooperating teacher. It is not until the second year that the intern assumes major teaching responsibility for a class. Course work is then limited to one three semester hour seminar each term.

Each instructor acts as resource colleague, advisor, and evaluator to twenty interns. He visits with each intern at least once every two weeks. This implies that a sample lesson is analyzed (video tape, etc.) every other week. This schedule is constant for the two-year internship period.

A cooperating teacher is responsible for two interns. In the first year she assumes major teaching responsibility with her interns working primarily at the individual or small group level. In the second year she relinquishes her class to one of the interns and technically remains the teacher of record. Another class must be "negotiated" for the second intern.

A five phase plan (model) for testing the pre-service program described above is outlined below. When completed, forty new elementary teachers will have been trained for the profession.

PHASE I: STAFF FORMATION AND IDENTIFICATION OF PROSPECTIVE INTERNS
(Ten month academic year, September - June)

A. Identify Professional Staff
   1. (10-12) University personnel including an analysis of teaching expert; "methods" specialists in math, science, art, language arts, social studies, and interdisciplinary studies; three assistants.
   2. (20) Elementary school teachers.
B. Identify Prospective Interns (40)
C. Select director and assistant both of whom should have experience in training teachers.
D. Negotiate with local school system regarding salaries, scheduling, equipment, evaluation, funding, etc.
   NOTE: The need for careful staff selection cannot be overstated. The period of time in Phase I for this purpose is minimal.

PHASE II: INSERVICE WORKSHOP FOR ELEMENTARY SCHOOL TEACHERS
(Eight weeks, summer following Phase I)

A. Present methods and materials courses to elementary teachers.
   1. (1st 2 weeks) math-science.
   2. (2nd 2 weeks) social studies-language arts
   3. (3rd 2 weeks) art-interdisciplinary
   4. (4th 2 weeks) analysis of teaching (using video tape, etc.)
B. Present learning theory course (concurrently with courses in A. above).
C. Prepare tentative schedules and identify teams for Phase III.
   NOTE: Phase II is an inservice training program for the elementary (cooperating) teachers and an opportunity for university personnel to test and refine the curriculum for the coming year. Coursework is similar to that which will be undertaken by the interns in Phase III.

PHASE III: INTERNSHIP I
(Ten month academic year, September - June)

A. Involve interns in class 5 mornings per week
B. Present professional courses to interns (same coursework as in Phase II-A--each meeting on separate afternoon, Monday-Thursday, for 2 hours, 3 semester hours credit/course)
   NOTE: For professional coursework, the interns are divided into two sections (20 each). The two-man subject area teams from Phase II are retained for as long as is necessary or desirable (possibly each could eventually handle both subjects in his area). If desired, the two sections of interns could be designated according to grade level preference (i.e. K-3; 4-6).

PHASE IV: EVALUATION
(Three weeks, summer following Phase III)

A. (1st 2 weeks) involve all professional staff and interns in an evaluation of Phase III.
B. (3rd week) Plan for Internship II (professional staff only).
   NOTE: Interns receive course credit for their two weeks participation. During this time their teaching performance (Phase III) is analyzed thoroughly.

PHASE V: INTERNSHIP II
(Ten month academic year, September - June)

A. Have each intern teach a class for a year.
B. Involve professional staff and interns in weekly seminar.
   NOTE: Each intern completes an in-depth study of a problem area related to his teaching and uses the seminar accordingly.

BUDGET ESTIMATE - 980 (limited space prevents detail; numerals in thousands).

Equipment and supplies - 63 (videotape - 25, curriculum material - 20, newsletter - 3, consumables - 15);
Transportation and professional meetings - 15;
Salaries - 902 (Phase I - 54, Phase II - 55, Phase III - 220; Phase IV - 28, Phase V - 500, Contracted services - 45)
NOTE: Cooperating teachers academic year salaries not included.

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SECTION SIX

PROMISING PRACTICES IN METHODOLOGY

IN SECONDARY TEACHER EDUCATION PROGRAMS

These ten papers describe new practices in the teaching of pedagogy and methods in secondary mathematics education. Many of the programs also involve short-term experiences in secondary schools or with secondary school pupils.

MATHEMATICS EDUCATION PROJECTS AT NEW MEXICO STATE UNIVERSITY

Eldon C. Boes
New Mexico State University

The Department of Mathematical Sciences at New Mexico State University utilizes five somewhat unusual programs in its efforts in mathematics education efforts. These programs are:

1. Instructorship for high school mathematics teachers.
2. High School Visitation Program
3. On-site in-service workshops
4. Teacher Retread Program
5. Mathematics Education Colloquium Series.

Brief descriptions of these programs are as follows:

1. Instructorship for high-school mathematics teachers.

For the past five years the Department of Mathematical Sciences at New Mexico State University has hired an outstanding high school mathematics teacher as a university instructor for one year. The duties are to teach three of the mathematics education classes each semester and to be active in the department. Generally, this instructor attends several graduate level mathematics courses during the year. This program has been very successful. A few of its advantages are:

(a) it rewards excellent teachers with an opportunity for a change of pace and further study of mathematics
(b) it provides future teachers with an excellent mathematics instructor who has recent "field experience," and
(c) it increases the flow of information between our faculty and high school mathematics teachers.

2. High School Visitation Program

This program, which consists of fairly regular visits to high schools of New Mexico by mathematics professors of New Mexico State University, actually serves the teachers, students, and administration of the host schools. During such a visit the professor gives talks in mathematics to several mathematics classes, answers questions the students pose, and discusses with the mathematics teachers any problems they might raise. The main advantage of this program is that it brings both the teachers and the students into contact with the Department of Mathematical Sciences at New Mexico State University and it lets them learn about some interesting topics seldom included in the standard high school mathematics

curriculum. This program has existed for several years; it has proven to be a very well-received and successful one. (During the past academic year at least one visit was made to every high school of the state). Occasional visits are also made to elementary and junior high schools.

3. On-site in-service workshops.

The School Visitation Programs revealed that many teachers of the state were interested in taking further courses in mathematics, especially if they could count it toward renewal of their teaching certificates. Since it's impractical for many teachers to attend regular university courses, the Department of Mathematical Sciences at New Mexico State University has begun offering a series of courses at various population centers throughout New Mexico. The contents of these courses vary with the needs of the teachers enrolled: they are taught by mathematics professors and they carry graduate credit. They normally last from one to six weeks. Tuition charges pay for the professor's travel and living expenses.

4. Teacher Retread Program.

To alleviate local shortages of qualified junior high mathematics teachers, the Department of Mathematical Sciences at New Mexico State University made an agreement with the Las Cruces Public School system to provide mathematics training for teachers in other disciplines. The entire program consisted of twenty-four semester hours in mathematics ranging from basic algebra through calculus. This Retread Program is proving to be a good solution for the shortage.

5. Mathematics Education Colloquium Series.

The Department of Mathematical Sciences at New Mexico State University started this program in October of 1971. The speakers and their topics are well publicized in the surrounding elementary and secondary schools. They are held at 4:20 p.m. so that local teachers can attend.

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A SECONDARY METHODS COURSE EMPHASIZING COMPETENCIES IN TEACHING BEHAVIOR

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and
Larry L. Hatfield
University of Georgia

The secondary methods course for preservice teachers at the University of Georgia stresses the development of teaching competencies in those behaviors that require interaction with students. In particular, methods students are expected to demonstrate ability to diagnose and treat individual learning problems of junior high school students (herafter referred to as pupils). In addition, the preservice teachers (hereafter referred to as students) are required to prepare and teach lessons dealing with various kinds of mathematical knowledge to small groups of pupils.

The course description which follows is a resume of the methods course as it was taught in the fall of 1971. Although this course is not considered to be in final form, it nevertheless represents a radical change from a methods course which is housed in a traditional university context. The first attempt to develop the present program was initiated in the Winter Quarter of 1970 largely because of dissatisfaction by both faculty and students concerning irrelevancies of a methods course which is devoid of public school experiences. The experiences in the current methods course, occurring in the formative stages of the development of a prospective mathematics teacher, were designed from a theoretical analysis of teaching. These experiences took place under the close supervision of a university teacher educator and introduced the students to methods of teaching in a limited but realistic setting.

The position was taken that teaching is basically an interaction cycle between teachers and pupils. Furthermore, it was assumed that the nature of the mathematical knowledge in part determines the strategies that teachers employ in the teaching of mathematics. Hence, students were given opportunities to analyze and participate in the interaction process and to contruct and teach lessons involving the various kinds of mathematical knowledge, viz., concepts, principles, and skills.

The first phase of the course was to develop some initial competencies in analyzing teacher and pupil actions as they occurred in actual classroom settings. To serve as one technique in analyzing classroom behavior, skill in using the Flanders Interaction Analysis was developed. This skill, combined with categorizing levels of classroom questions and judging the extensiveness of student participation were utilized in analyzing the actions of observed teachers. In observing pupils, students were asked to identify occurrences of defensive strategies that pupils use as identified by John Holt in How Children Fail.

The remainder of the course consisted of three additional phases: tutoring, microteaching, and simulated episodes in classroom management. The tutoring situation usually involved one student and two pupils. Typically the pupils had learning problems and were identified by their teachers as needing help in particular areas. The students were expected to demonstrate ability in diagnosing and treating specific learning problems. In so doing, the students were to write behavioral objectives for their tutorees and write test items that reflected their stated objectives. The tutors were expected to evaluate the progress of their pupils not only in terms of achievement but also in any perceived differences in the affective domain. At the conclusion of the experience the students were asked to write a paper identifying the specific learning problems of their pupils and discuss the activities they utilized in trying to overcome the learning problems. Each daily tutorial session was supervised by the instructors with the aid of a graduate assistant.

The questionnaire below indicates the reaction of the 31 tutorees. Although they came to the sessions somewhat apprehensive, their responses indicate their resulting enthusiasm for this activity.

I found that small group meetings
29 A. helped me very much
2 B. helped me a little
____ C. didn't help me
____ D. confused me and made mathematics harder to learn.

It is imperative that public school personnel believe that they too derive some benefit from a cooperative venture with the University. The item above is one reason for the acceptance by the public schools for this program.

The third phase of the course involved students demonstrating, in microteaching settings, their competency in teaching mathematical concepts, principles, and skills, and in utilizing discovery methods. Various strategies, based on Henderson's work, for teaching concepts, principles, and skills were presented to students in lectur-discussion sessions and were modeled through videotaped demonstration lessons. Methods of teaching by discovery were also discussed and modeled in a similar fashion.

Working in pairs, students then designed lessons for microteaching sessions utilizing the strategies discussed in class. Each pair of students finalized their written lesson plans in concert with a doctoral student in mathematics education. The lessons were taught the following day to a group of 3-5 junior high school pupils and immediately critiqued by the doctoral student. By having students plan and teach in pairs (student A teaches while student B observes and then they interchange roles for a new group of pupils). it was felt that the quality of planning was improved and that the benefit derived from the critique was enhanced.

Each critique was based on a set of questions designed for each microteaching session. Below is a sample set of questions developed for the critique of the lesson on principles:

1) What is the objective (behavioral) for this lesson?
2) What evidence was obtained to indicate that the students reached the objective?
3) What moves were used to introduce the principle?
4) What moves were used to interpret the principle?
5) What moves were used to justify the principle?
6) Which moves appeared to be effective? Explain.
7) Were there any mathematical errors?

To prepare for their supervisory roles the doctoral students participated in a weekly siminar that dealt with the nature of microteaching and Henderson's moves for teaching various kinds of knowledge.

To assist students in attaining a satisfactory level of competence in teaching mathematics, two reteaches were scheduled. A reteach was a repeat of a microteaching session that was judged to need improvement. Videotape equipment was used to enable each student to analyze his teaching performance. Due to limited facilities each student had the experience of being videotaped only once. The pupils that participated in the microteaching sessions enjoyed this experience. This is evident from the following responses to an item taken from a questionnaire given to these pupils. The enthusiasm of the students is one additional reason for the acceptance of this program by the schools involved.

How did you feel about participating in microteaching?
30 A. I enjoyed it very much.
2 B. It was O.K., but nothing special.
0 C. It was boring.

The concluding phase of the course was devoted to identifying guidelines useful in classroom management. Students were assigned roles to play portraying discipline problems as they typically occur in various classroom settings. Both effective and ineffective methods of coping with problems evolved from subsequent discussions of these simulated episodes.

Students were scheduled to meet two hours a day, Monday through Friday. However, all of this scheduled time was not utilized. Typically meetings at the junior high schools and those meetings with microteaching supervisors involved one hour. The time allocated for each activity is given below:

PhaseI
- A) Using Flander's Instrument - 5 hours (2 1/2 days)
- B) Discussion of Holt's, How Children Fail - 5 hours (2 1/2 days)
- C) Observing in Schools - 3 hours (3 days)

Phase II
- A) Writing Behavioral Objectives - 4 hours (2 days)
- B) Tutoring Pupils (excluding travel time) - 20 hours (13 days)

Phase III
- A) Discussion of Teaching Concepts and Viewing Videotape Demonstration - 6 hours (3 days)
- B) Planning Meeting with Supervisor - 1 hour (1 day)
- C) Microteaching - concepts - 1 hour (1 day)

D) Repeating A-C For Teaching Principles - 8 hours (5 days)
E) Repeating A-C For Teaching Skills - 8 hours (5 days)
F) Repeating A-C For Discovery Teaching - 8 hours (5 days)
G) Reteaches - 2 hours (2 days)

Phase IV

A) Simulated Episodes and Discussions of Classroom Management - 4 hours (2 days)

Note: Approximately 6 hours (3 days) were devoted to miscellaneous items.

The seventeen students taking the course rated their experiences as being highly beneficial to their professional development. Below are excerpts taken from a questionnaire given at the conclusion of the course (16 of the 17 students responded).

i) I believe that specific information obtained from this course is, or will be:

12 A. extremely useful
3 B. generally useful
1 C. of little use
____ D. of no use at all

ii) Rate the following activities:

A. Observing teaching -

1 Excellent	7 Fair
6 Good	0 Poor

B. Tutoring students -

10 Excellent	1 Fair
5 Good	0 Poor

C. Microteaching sessions -

13 Excellent	0 Fair
2 Good	1 Poor

In giving a general reaction to the course on an open ended item, 13 students responded. Eight of these reactions were very positive and five were positive, none of the reactions were judged neutral or negative. A number of the students were concerned with the substantial amount of time the course required. Some felt that more than 5 quarter hours of credit should have been given.

In addition to having a stimulating course for prospective teachers, additional benefits were derived. Doctoral students responded very favorably to the supervisory experiences and to the opportunity of seeing how theoretical aspects of instruction can be translated into viable preservice practices. Furthermore, a cooperative atmosphere was fostered between local schools and the University. Besides the individual help that pupils received, the staff members of the junior high schools enjoyed interacting with both University faculty and students.

In the initial development of this course (Winter Quarter, 1970) the tutoring sessions were held every other day and the microteaches were distributed throughout the week and supervised by a single instructor. We feel that the present program represents a much more sophisticated and polished product. This progress is due largely to the increase in support given by the Dean of the College

of Education. Such support has taken the form of increased work-load credit and the assignment of a graduate student to assit in the activities of the course. If practical problems could be resolved the instructors would like to see some teaching competencies demonstrated on a mastery basis as advocated by Bloom and others. Such a commitment is also contingent upon further research involving the efficacy of certain teaching strategies and the determination of criterion measures for judging competence in implementing these strategies.

While such factors as the accessibility of junior high school pupils, the assistance of doctoral students, the utilization of video-tape equipment complemented the basic innovative aims of the course, these aims were not dependent entirely on these factors. The basic innovative aims were the development of competence in specific teaching behaviors, such as diagnosing and treating content. These specific behaviors could be emphasized in a less glamorous fashion without the aid of the factors mentioned above.

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SIMULATION OF MATHEMATICAL ACTIVITIES IN A METHODS PROGRAM

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Mathematical modelling is a relatively new emphasis in the secondary school mathematics curriculum. Mathematical modelling is defined here to mean the identification of an appropriate model, the collection of data, together with the interpretation of results. An assumption that this process is as important for the secondary school student as is computational proficiency must inevitably imply some changes in the content and methodology of the classroom environment.

Data collection, while an essential ingredient of the modelling process, is time-consuming. But if students are to gain practice in working through the complete process, especially the drawing of inferences based on large samples of data, the data collection step cannot be overlooked. This suggests a need for simulation of data. One way of simulating data is by the use of coins, dice and spinners, and these avenues should certainly be explored. But the simulation of large samples of data would seem to suggest the use of the computer.

In the same way, the analysis of problem-solving behaviors and the search for patterns lends itself to computer representation.

Some of the new topics in the secondary school mathematics curriculum are also new to the prospective teacher of mathematics, at least at the intended level of treatment. It is the contention of this writer that a course of pre-service training should focus on the presentation of situations appropriate to the secondary level. By experiencing that which they may be expected to teach, the student teachers are exposed to both the content and methodology of the mathematics curriculum. From this starting point, they are in a position to go on to try planning suitable learning activities for their own classroom use.

This format is felt to be appropriate for familiarizing the student teachers with the uses of computer simulation at the secondary level.

The twenty six student teachers are seniors with majors in the mathematics teacher education curriculum in the College of Liberal Arts and Sciences at the University of Illinois, and are undertaking their professional education semester. They are all enrolled in the author's course "Techniques of Teaching Secondary School Mathematics" which meets during nine weeks of the semester, the remaining six weeks being devoted to student teaching practice.

The innovation described herein occupies six class hours of the Methods program. The implementation of this program is in the

hands of the author. The student teachers have direct access to an IBM APL/360 typewriter terminal and spend about eight hours working with the computer.

As a prelude to this activity, the use of the computer as an aid to problem-solving has been discussed. Problem-solving strategies have been explored with reference to suitable material from the secondary school curriculum. Games situations such as "Jump-it", Tower of Hanoi and Nim have been found to be appropriate for this. The emphasis is on having the student find a rule or devise a strategy as an outcome of the activity.

The Methods program deals with various aspects of simulation: the generation of substantial sets of data in probability experiments, the conduct of hypothetical physics experiments, playing a game of strategy according to given rules, and "find-my-rule" type activities. The place of these activities in the secondary school curriculum is discussed. Then the student teachers, being essentially unfamiliar with simulation activities, initially experience them as high school students would, and then explore ways of using the activities in the secondary school program.

In one class session in this unit, the student teachers divided into groups to play one-pile Nim. Winning strategies were devised, and arising from a synthesis of these, the class developed a flow chart for programming a winning strategy for the game. Then the effect of varying the number of counters was explored. As a followup to this session, the student teachers played the game with the computer, and then played other games of strategy that have been programmed. Finally, they addressed themselves to writing a flow chart or program for some other game of strategy.

In another session the instructor simulated a function generator. Suppose the rule to be determined was $f = x^2 - 4x + 1$. The student teachers input a series of values of x, and the "function machine" (instructor) gave the appropriate values of f. This gave rise to the construction of a table of values, and from this the rule was found. As the session continued, student teachers assumed the role of the "function machine."

The possibility of using a vector as an argument in APL is an attractive feature of the computer approach to the above type of problem. Using APL with the example above, we obtain a ready-made table of values in the following form:

```
      X ← 0 1 2 3 4 5 6

      F X

1 -2 -3 -2  1 6 13
```

The same approach can be used in considering dyadic relations, for example, the greatest common divisor of two numbers a and b. Again the student teachers input values of a and b and the "machine" responds, the activity continuing until the rule is identified. Using APL we obtain, for example, the following sets of values:

8 G 12

4

9 G 12

8

24 G 40

8

After class exposure to the various simulation activities, the student teachers, in groups of three or four, work at sample activities which have been stored in the computer. The writer is indebted to the work of D.E. Iverson and others of IBM for ideas on a number of these activities.[1] Some of these programs are of a "black-box" variety; that is, the student teachers cannot inspect the author's program, but must simply follow the directions given. The "find-my-rule" programs and hypothetical experiments come into this category. Other programs are of a "glass box" type. Here the student teacher has the opportunity to inspect the program to try to determine why it does what it does. Games of strategy and games of chance come into this category. For example, a student teacher plays games of craps against the computer and collects data which should enable the probability of winning to be seen as the long-run relative frequency. Inspection of the program will help him to see how the conduct of the game has been simulated.

To this point, the activities provide the student teachers with experience of the type intended for high school students. Now we want to see if the student teacher can plan activities of this type for his own teaching. To this end each student teacher is asked to plan such activities and to indicate how they might be used in the secondary school curriculum. Hopefully, they try out their programs on other student teachers.

The author hypothesizes that student teachers who demonstrate greater proficiency in the use of simulation techniques in planning for their teaching experience will exemplify a more flexible teaching style than will those whose use of simulation is not so proficient. It is further hypothesized that this approach will lead to higher student attainment of important objectives for the secondary school mathematics curriculum. The writer is exploring these hypotheses with the current group of student teachers.

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[1] See especially Falkoff, A.D. and Iverson, K.E. The Use of Computers in Teaching Mathematics, IBM Technical Report No. 320-2986, April 1970.

MICRO-TEACHING ADAPTED TO THE PRESERVICE EDUCATION OF SECONDARY MATHEMATICS TEACHERS

Henry Garland
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A student teacher's first teaching experience often involves these conditions:

a. a class of 25 to 35 students
b. a 45 to 55 minute class period
c. non-instructional activities
d. classroom discipline problems
e. some notes written by the supervising teacher recording part of what was said and part of what was written on the blackboard during the lesson
f. no opportunity to teach the same lesson again and correct mistakes made the first time

The conditions of micro-teaching (MT) foster the identification of remediation of a student teacher's weakness(es). Some of these conditions are:

a. a class of 4 students
b. a 10 to 12 minute lesson (class period)
c. no non-instructional activities
d. easy "classroom control"
e. a video-taped recording of the teaching episode which includes everything said by the teacher and his 4 students, as well as everything written on the blackboard during the lesson
f. an opportunity to teach the same lesson again and correct mistakes made the first time.

At Florida State University micro-teaching (MT) is part of a practicum course, required of all secondary mathematics education majors in the quarter just prior to their student teaching. MT is preceded by 4 weeks of college classroom instruction (20 lessons) in strategies used in teaching mathematics. A follow-up to MT is 1 week of observation and 1 week of teaching a class under supervision at the university's laboratory school.

A form of MT was initiated by this summary's author in 1965. Previously the instructor had taught high school mathematics for 8 years and college-level mathematics education for 3 years.

The procedures of MT were altered several times before MT reached its present form. The MT work of Drs. Dwight Allen and David Young suggested the incorporation of a teach-reteach cycle.

For the past several quarters some FSU Academic Year Institute participants have assisted the MT instructor. Such persons quickly learn to operate the video taping equipment and to conduct critiques of the MT episodes.

MT is more profitable if the teaching episode is recorded on video-tape. Our program uses a SONY 1/2-inch system, which has proved to be reliable, portable, and easy to operate. A zoom lens is needed on the camera to make blackboard writing visible.

Only a few reels of video tape are required since a tape may be used over and over again.

Timewise a teaching episode is about 12 minutes. Conducted later in the afternoon, the critique takes about 1 hour. A "class" of four students is needed for each teaching session. In our program the 4 students are selected from a mathematics class at the University School (FSU's laboratory school). They report to the MT session during the last 15 or 20 minutes of their class. Their regular teacher has designed the day's lesson so that the four students may be absent from the classroom during the last part of the period.

A TV studio is not necessary for MT. Our facility is the University School's mathematics laboratory. The basic requirement is a room with a blackboard. The camera is operated from a tripod at the rear of the room.

In our program the student teacher proceeds through a teach-reteach cycle involving these activities in sequence:

1. Prepare a 10 to 12 minute lesson
2. Teach the lesson to 4 students
3. Participate in a critique of his first-teach of the lesson
4. Revise the lesson based on the critique
5. Teach the revised lesson to a different group of 4 students
6. Participate in a critique of his second-teach of the lesson

Comments on the Activities

1. The topic of the lesson is assigned by the class instructor.
2. a. The teaching episode is recorded on video-tape.
   b. The "class" of 4 students is made up of two boys and two girls. in ability the class contains one above average, two average, and one below average student to represent the range found in most classrooms.
3. The first critique consists of these activities in sequence:
   a. The student teacher views a first playback of his tape without comment from the directing teacher
   b. After the first playback the student teacher identifies 3 or 4 strategies performed satisfactorily. Then he identifies 2 or 3 behaviors that should be changed. The directing teacher must elicit as many compliments as criticisms to maintain the student teacher's self-image. This activity is the first step in developing a student teacher's ability to analyze his own teaching performance.
   c. Then the directing teacher and student teacher discuss the teaching episode. If the former sees many weaknesses, he should mention no more than 3. The typical student teacher

should not attempt to modify more than 3 behaviors at a time. Focusing on more would overwhelm and confuse the student teacher at this stage.

d. Next, the student teacher views a second playback of his tape or a playback of a model tape which demonstrates successfully the skill(s) to be altered. This time the directing teacher stops the tape occasionally to ask a question or make a suggestion. A brief segment may be replayed 2 or 3 times to make a necessary point.

e. The critique is summarized by having the student teacher state the 2 or 3 skills and strategies he will try to alter in his second teach.

4. The directing teacher avoids telling the student teacher in detail how to modify his performance. The student teacher must attempt this by himself.
5. The student teacher's second "class" of 4 students is selected to be comparable to his first class.
6. The second critique consists of these student teacher activities:
   a. He recalls the 2 or 3 behavior to be altered.
   b. He evaluates his performance in those 2 or 3 areas before viewing his tape. The directing teacher stops the playback occasionally to ask a question, to point out a strength, or to offer a suggestion.

Topics selected for MT should meet these criteria:
1. The class of 4 students has studied the pre-requisite materials
2. The class of 4 students has <u>not</u> studied the assigned topic
3. Closure can be accomplished in 10 to 12 minutes
4. The student teacher can demonstrate some important skills and strategies required in teaching mathematics

<u>Examples of Topics Suitable for MT with Corresponding Grade Levels</u>
1. To find a given term of a (arithmetic) sequence, like the 51st term of 7, 11, 15, 19, ...; grades 6-11
2. To find the sum of the first n odd natural numbers, like
   $\underbrace{1 + 3 + 5 + 7 + \ldots}_{\text{first 20 odds}}$; grades 6-9
3. To add pairs of integers, like -6 and +2; grades 6 and 7
4. To draw the number line graph of sentences like $(x \pm 2)(x \pm 5) \leq 0$; grades 8 and 9
5. To find a Pythagorean triple x, y, z ($x < y < z$) for any given odd number x, like (15, y, z); grades 8-10

<u>Examples of Teaching Skills and Strategies Which May Be Evaluated, Improved, and Modeled by MT and Video Tape Recording</u>
1. use of <u>questioning</u>
2. use of discovery method (or teaching by patterns)
3. selection of opening examples
4. avoidance of over-verbalization, etc.

Sometimes one video-taped episode will vividly portray some of these skills. This tape is made part of a "bank" of model tapes. Such models are shown in the college classroom, where viewing one short video-taped lesson with discussion is more effective than an instructor's lecture.

Researchable Questions

1. During the first critique should the student teacher view his own tape a second time or a model tape?
2. Should the student teacher view the first playback of his tape alone? with his instructor? with his peers?
3. Can MT alter behaviors of the in-service mathematics teacher?

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STUDIES IN MATHEMATICS INSTRUCTION: AN EXPERIMENT IN PRE-SERVICE TEACHER EDUCATION

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Herein is described a new approach to the field specialty component of the professional education program for pre-service junior high and high school mathematics teachers. It is being conducted in lieu of the "special methods" programs of the traditional kind. Although still in the infancy of its development, the program appears to hold good promise of evolving into an unusually sophisticated and fruitful method for preparing participants realistically for their instructional duties in the schools.

The program discussed focuses exclusively on Mathematics Instructology and is adjoined to the practice teaching and general professional program. The tactical objective is to give the participant an unusually broad perspective of, and deep insight into, mathematics instruction and the relevant teaching-learning processes. It is anticipated that such a perspective, supported by practical experiences which engage the participant in unusually deep and detailed investigations in areas of special interest to him, will permit him during his subsequent teaching practices to inquire more deeply, creatively, and fruitfully than otherwise into the inner workings of mathematics instruction.

That the widely invoked conjecture that such a change in perspective does produce broadly transferable results can be applied also in settings that are peculiar to mathematics, is supported by recent results. As an example, one participant devoted a full semester's course work to analyzing in great detail the curriculum of a leading kindergarten text (finding it mathematically and psychologically disasterous) and to devising an instrument for assessing such texts; this experience led to a radical change in his classroom approach to teaching high school general mathematics in which he was engaged concurrently through the practice teaching program.

The pre-service program is only a little over a year old, but has an experience base of several years' duration. It is a new effort to incorporate into the undergraduate program a number of training experiences which have proven fruitful to in-service teachers when acquired through College-School Cooperative programs at IIT and Academic Year Institutes there. In fact, the general approach was suggested by reports from several in-service participants that their special training in mathematics curriculum design, while failing to make accomplished designers of them, was

radically affecting their classroom methodologies--far more so than normally is done through methods training per se.

Apparently, the teacher typically regards himself as an actor in the instruction play. The shift of perspective sought is for the teacher to regard himself as the director of that play, being responsible for its total effectiveness whether or not he also functions as an actor in the scene. To produce this results, instruction is viewed as the task of inducing the learner to grow, cognitively and affectively, to assume a minimal prescribed form. Training is coordinated through discussion sessions which interrelate considerations of mathematical content, curriculum design, learning theory, communications, testing, and so on; from this basis, students engage in deeper, independent work in materials analysis and tutorial settings, and the like.

Consideration is given to those aspects of instruction which inherently are interlocked with the teaching of mathematics proper including:

(1) Structural learning theory as it relates to the acquisition of mathematical knowledge,

(2) Curriculum design; here, "curriculum" is used to mean: (a) the prescription of specific information items to be learned, including information in mathematics, information about mathematics, and attitudes toward the acquisition and use of mathematical knowledge and skills (i.e., skills in precise, logico-theoretic analysis), together with (b) the organization of specified items into "paths" or, more generally, "networks" of progression over which the student may be led to achieve the learning prescribed;

(3) Instructional media: Here "instructional medium" is used in the theoretical sense (as opposed to the "hardware" sense) with consideration being directed to the identification of those experiences in which the learner can be immersed by way of inducing his growth along the prescribed curricula, and

(4) Instruction monitoring: here, attention is focused on progress assessment and clinical testing methods for diagnostic and prognostic purposes.

The dearth of formal study materials in these areas is offset by practical work in curriculum design, media design, and test design, all in relation to tutorial-type instruction with underachieving students. Emphasis is placed more on how the participant handles the design problems than on the broad usefulness of the results of his efforts. Naturally, he gains much more when recognizing that his own efforts may produce results significant to the field as well as to himself.

Admittedly, the pre-service program cannot go into such great detail in very many areas. It is assumed, however, that there is far too broad a field of potential study to apply the "basic education" principle to professional content items; rather, focus is on development of uncommonly strong professional skills to design, implement, and monitor instructional programs especially tailored to his own students.

The general rationale for such a program is well known, but two specific issues are worthy of additional note:

(1) The small program problem: The loosely structured program currently being used is consistent with difficulties shared by many colleges which, while collectively producing large numbers of teachers, individually have relatively small teacher education programs. The IIT program normally produces less than ten mathematics teachers per year. As presently structured, one staff member can handle the new program although providing the necessary individualized training experiences requires much more preparatory time than would a traditional course. While an expanded program could effectively use more staff with varied interests and involve elaborate resources, the objectives of providing unusually penetrating perspective apparently can be relatively well met even in a small program conducted in a simple setting.

(2) The Academic Subject Problem: This has two related components: (a) the transportation problem: students typically have great difficulty in bringing their relatively deep grounding in subject area knowledge to bear meaningfully and fruitfully in making professional decisions about instruction in that subject, and (b) the academic separation problem: for the most part, academic subject specialists in college departments, who tacitly provide the basic examples for prospective teachers to emulate in subject area instruction, have not become seriously engaged with the nature or proceedings of instruction proper. This serves to the special disadvantage of prospective teachers. The problem is especially acute where the pre-service program is too small to justify full-time staff in Mathematics Education.

This problem does not appear to be based in personal disinterest. Rather, academic specialists have not found in the traditional "special methods" programs sufficient substance in academic content or productivity in the development of real professional skills to warrant re-allocation of their own activities in this direction; neither have they been provided any real indication that their subject area expertise could contribute substantially along those lines.

In developing the IIT approach, however, it has become apparent that the basic questions of learning, curriculum design, media design, and test design are heavily interlocked with the very nature of mathematical inquiry. Here, then, is substantial potential for the involvement of academic specialists, not so much with regard to subject area knowledge esoteric to the schools, but through the experience of the mathematical researcher in the art of re-organizing and re-interpreting mathematical information. Indeed, staff skill in the latter area appears to be so critical to the effective conduct of this program, that a master's degree in mathematics, the level of mathematical attainment typically associated with Ph.D. programs in Mathematics Education, is not itself any indication of a staff member's qualifications to conduct a program in Mathematics Instructology. Admittedly, a mathematician must be willing to look a ways into structural learning theory and communications before he could be expected to conduct a comprehensive program himself.

So far, all work has been conducted through seminars and independent study programs with only about a dozen students having been involved. This "experimental" context presently is being retained for the flexibility it provides in gradually developing a comprehensive program in Mathematics Instructology for formal incorporation in the pre-service program. The resources presently required are minimal, consisting mostly of selected school-oriented instructional materials, a compendium of papers of which most were prepared at IIT, and access to school students. Subsequent expansions of the program would be expected to invoke more elaborate systems for diagnostic/prognostic testing, materials development laboratories for experience in implementing curriculum designs, mathematics clinics equipped with video-tape recording systems for case analysis, and so on.

The above discussion reveals several researchable questions of which two, when properly decomposed, seem basic to the prospects for the widespread usefulness of the program: (1) "Can 'professional perspective' be defined in a way so as to be broadly meaningful in teacher education and provide a useful separation of teacher performance?" and (2) "What skills in structural learning theory, communications and mathematical theorization are essential among staff members in order to provide a bonafide program in Mathematics Instructology?"

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A SUMMARY OF A UNIT IN TESTS AND MEASUREMENTS FOR PRESERVICE TEACHERS OF MATHEMATICS

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Feedback from undergraduate interns and from other sources clearly indicated several years ago that preservice mathematics teachers did not feel prepared to take on the regular testing activities of a mathematics teacher, such as:

1. writing a weekly, unit, or term test
2. scoring a test
3. assigning grades.

Mathematics educators and psychometricians have developed techniques that teachers can put to good use in improving their testing procedures. Such content has not been a regular part of the undergraduate program in all teacher education institutions. Even when offered, it has frequently been taught by faculty with a broad concern for test and measuremenets in a general course whose enrollment included students from a wide variety of backgrounds (English, social studies, science, foreign language education majors, etc.). Should such a topic as item writing and test development be done in this context, the faculty member has frequently been unable to help the student in any specific way, or to evaluate his work.

For such reasons, it was decided to include a testing unit in Mathematics Education 443, The Teaching of Algebra, a course specifically designed for preservice teachers of mathematics only. Undergraduates normally take this course in the late junior or early senior year. They must have met the admission requirements of the College of Education and the Department of Mathematics Education, have taken an introductory course in mathematics education and be well along towards their equivalent to a major in mathematics.

This unit of instruction normally requires 3 weeks out of a 3 quarter hour course. One form of a commercially available standardized Algebra 3 test is used. The Evaluation Services unit of the University Division of Instructional Research and Service scores, item analyzes, and prepares a frequency distribution for a test, as described below; there is no charge for this service.

At the first class meeting, students take a standardized examination designed for high school or early college students in an advanced algebra course. Despite their more advanced mathematical standing, students discover they have forgotten some mathematical topics and never learned others. This motivates these resulting activities:

1. A study of the high school algebra curriculum: students check the content of the standardized test against current high school texts and recommendations like those of the Commission in Mathematics.

2. A study of the uses of grouped frequency distribution, mean, and standard deviation: students are curious to know how well they did as compared with others, as can be shown via the frequency distribution, mean, and standard deviation for the class, and the computation of standard scores. They learn to compute the last three from a grouped frequency distribution.

3. A study of item analysis techniques: students want to know whether their errors are commonly shared, and whether they result from their own deficiencies or item ambiguities. They learn to form high and low groups, and to do item analyses for different item types.

4. A study of norms: students want to know how well they did as compared to the students they will soon teach. This leads to a consideration of percentile norms, and using the test manual to determine the nature of the norm group and ways to take care in interpreting scores.

The students are now ready to try their hand at item writing and test development. This is done by preparing a test for a part of a chapter in a commercially available Algebra 2 text. The class is split into two halves. Each prepares a test for the other half. Students within a group critique each other's items, using standard review technique. After administering the test, each half-group scores and grades the test, using techniques recommended by the instructor and some readings from The Mathematics Teacher.

This technique has been evaluated via feedback from the students at the end of internship. They express greater confidence at this teaching task than did their predecessors.

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MATCHING INSTRUCTIONAL MODES AND TEACHING ACTIVITIES

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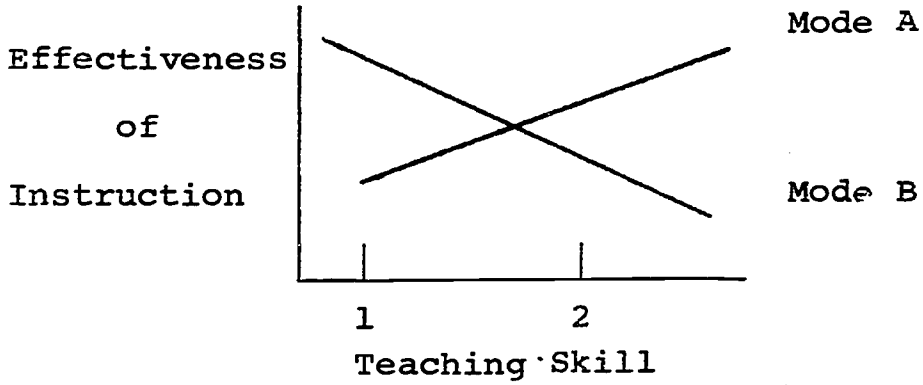
The present preservice secondary mathematics program at Purdue University consists of a "professional" half-semester during which the student is confronted with the principles, methods and content of teaching secondary school mathematics before participating in a student teaching experience. An obvious difficulty in working within such a program is the selection of topics and experiences that will be maximally beneficial in helping the student become effective both in and outside of the classroom in a short time. The most typical approach in dealing with the problem would be to resort to the lecture method in order to "cover" as much material as possible. In the belief that classroom time ought to be devoted to the discussion, demonstration and actual practice of good teaching both by the professor and the prospective teacher, an alternative was sought.

Some type of independent study program seemed to be indicated in order to present the necessary material and still have time for student practice of teaching skills. A staff member had been given released time to develop auto-tutorial lessons on the course content. The original intent was to attain a more individualized approach and also to make more efficient use of a limited staff with the prospect of increasing enrollments. While these needs continue to be important, it seemed difficult and somewhat undesirable to use auto-tutorial materials to present much of the material relating to actual teaching skills. On the other hand, many of the skills that teachers must have are used outside of the classroom and are done independently. These skills can and ought to be presented by an auto-tutorial approach. With these thoughts in mind, the criterion settled upon for deciding which aspects of a topic to develop in class and which to develop auto-tutorially was: "Which aspects relate to skills carried on by the teacher in the classroom and which relate to skills needed by the teacher outside the classroom?"

An additional instructional resource was the availability of the micro-teaching lab. Due to heavy use of the facility it was possible to schedule each student for only two 5-minute teach-reteach sessions. It was decided to use the lab to give students individualized practice in two skills: "questioning" and "motivating."

The "Evaluation" unit from the Principles of Teaching course for secondary mathematics majors illustrates skills that were dientified for each of the instructional modes along with the activities that were used to teach the skills. The activities were completed in three class sessions plus the arranged micro-teaching lab time. The staff consisted of a professor, a graduate assistant, and a lab assistant who runs the micro-teaching lab for preservice courses in all subject matter areas.

The effectiveness of this attempt to match instructional mode to the type of teaching activity or skill has not been formally evaluated. The approach suggests the possibility of an interaction between teaching skills and the instructional modes used to present the skills. One might predict that the closer the instructional mode to the setting of the eventual use of the skill, the more effective the instruction. For example, if a teacher is eventually going to score tests (Skill 1) independently, it would be most effective to teach test scoring in an



independent study setting (Mode B). If questioning (Skill 2) is eventually going to be done in a classroom setting (Mode A), instruction in questioning skills ought to be done in a classroom setting. It may even be possible to identify finer distinctions between teaching skills and between instructional modes and to attain a better fit than the somewhat rough approximation suggested here.

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ANALYSIS OF A COMBINED SECONDARY MATHEMATICS AND SCIENCE METHODS COURSE

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The author, instructor of a secondary mathematics methods course, in collaboration with his counterpart in science, developed a combined secondary mathematics-science methods course designed to: 1) develop a commitment among future teachers to viable teaching practices through active involvement and self-exploration and 2) integrate mathematics and science objectives similar to the work done by the MINNEMAST Project for the elementary level.

The collaborators felt that there was a need for:

1) decreased emphasis on transfer of training and increased emphasis on developing experiences which influence critical elements within personalities; and
2) improved communication between science and mathematics teachers at the secondary level as well as integration of various phases of the mathematics and science curriculum.

The first goal could be satisfied just as well, perhaps with greater success, in an integrated methods course.

There is abundant evidence that much of the material "taught" in methods courses does not carry over to actual teaching. There is also strong feeling that too much emphasis is being placed on "degree of transfer" in evaluating methods courses. The success of a beginning teacher may depend more on factors that cannot be controlled in the simulated environment of preservice experiences. For example, the success of a beginning teacher may be due to his personal adaptability to the principal, the pupils, the setting, and the role expectations he must face on his teaching assignment rather than to any similarity between his student teaching practice and his first teaching situation. Consequently, perhaps teacher education would be better served by seeking to learn more ways of developing elements within individuals rather than trying to reconstruct identical situational elements between preservice and in-service experiences.

The above objectives can be well served in an integrated mathematics-science methods course with the ancillary objective of encouraging preservice students in secondary science and mathematics to:

1) Present mathematics and science as part of the continuing endeavor to interpret man's function in his environment.
2) Present mathematics and science as changing, creative disciplines, in order to lessen the isolation of school instruction from current research, from research scholars, and from those who apply research results.
3) Supply experiences in the teaching of the processes of physical and biological sciences and skills in mathematical techniques as are needed by everyone in order to function effectively in society.
4) Provide a sound foundation for the training of future professional mathematicians and scientists as well as a viable attitude toward science and mathematics for all students.

The mathematics-science methods course is taught on a team-teaching basis by the respective mathematics and science specialists in the Department of Science and Mathematics Education. The students enroll for either Secondary Mathematics Methods or Secondary Science Methods, but not both. Enrollees are either seniors or graduates with majors in mathematics, physics, chemistry or biology and this is the course that directly precedes student teaching. The class size usually averages about 9 - 14 mathematics majors and an equal number of science majors. The class meets once a week for three hours, yielding two semester units of credit.

The course attempts to meet its objectives by using micro-teaching techniques, guest lecturers, field trips, and participation in self-evaluation and self-analysis.

Students from a nearby high school are brought in for special video-taped micro-teaching lessons. The high school students react during the lesson and after, thus providing valuable feedback to prospective teachers. Video tapes are reviewed for general behavior patterns at first and then more carefully toward the end of the semester by using some measure of teacher behavior (e.g. Flanders System of Interaction Analysis).

Guest lecturers include local teachers or administrators, known educators (via video tape), or sometimes representatives of companies dealing in educational aids. (e.g. one guest involved the class in a simulation of a teacher in a particular ghetto school situation--the prospective teachers participated in role-playing techniques in approaching their solution to the simulated problem; another guest introduced the class to the technique of Systematic Sociometry as a means of solving discipline problems and motivating students in science and mathematics). This semester the class took a field trip to a local junior college noted for its research in computer assisted instruction.

Besides certain tasks such as setting up of a laboratory experiment, teaching an activity-oriented lesson or developing questioning techniques in a lesson, prospective teachers are encouraged to communicate with high school students, guests, each other and the instructors in order to better understand each group and draw out a commitment to education.

The feedback that the instructors have received from the prospective teachers has not all been positive but it has been constructive. Next semester the class will be meeting at a local high school with the students in a natural setting.

The following questions are pertinent:

1) When these students begin student teaching will there be transfer of the minimal skills we expect?
2) Will this batch of student teachers be more successful in terms of a) teaching their subject matter b) understanding the needs of the high school students c) fitting in professionally?

There will be a follow-up of the student teaching experience of each student by the methods instructors who also assist in the supervision. By analyzing video tapes of various lessons and comparing them to earlier tapes, the instructors hope to collect enough data to yield at least partial answers to the above questions.

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INNOVATIVE SEMINARS FOR STUDENT TEACHERS

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Undergraduates, while student teaching, often have little contact with their home campus. They have no convenient way of sharing their experiences with their peers, of asking a mathematics professor about a troublesome topic, of becoming acquainted with alternatives in textbooks, supplementary materials, and teaching aids, or of becoming involved in the production or field testing of experimental materials. Many do not realize the relevance to teaching of what they have studied in mathematics or mathematics education classes until they begin to experience problems in teaching mathematics.

Observations such as these led to implementation of a Preservice Institute for Teachers of Mathematics (PITM) at Illinois State University which involves participating student teachers who return to campus to meet in that Center for a full day of seminars, lectures, and discussions on six of nine possible Fridays. Participation is voluntary and requires joint permission of the high school administration and high school supervisors. Each nine weeks approximately 25 of 29 eligible student teachers participate. Their high school supervisors also meet on one or two Saturdays for orientation, coordination, and evaluation.

The National Science Foundation supported the institute on a budget that gradually phased out federal support over a four year period. The proposal was a joint effort of representatives from the departments of Mathematics, Professional Laboratory Exercises and University High School. The initial budget supported 1-1/2 faculty positions (which was distributed among 5 staff members), a full time secretary-librarian, mileage and a nominal book allowance for participants, and funds to build a materials center. The university arranged space for the materials center adjacent to a seminar room.

Charles E. Morris is the Institute Director. Kenneth A. Retzler is the Associate Director of the Institute and Director of the Materials Center. Conrad Carroll, Lynn Brown and Dwight Coblentz are Coordinators. Drs. Brown, Coblentz, Morris and Retzer are members of the mathematics department. Mr. Carroll is a member of the mathematics faculty at the University High School and Dr. Coblentz is a college supervisor of student teachers.

Each of the six institute sessions has a central theme. The first day is devoted to orientation to the PITM goals, contemporary

recommendations in mathematics curricula, history of modern mathematics programs, and characteristics of professional organizations. Subsequent sessions center around the subject matter areas of general mathematics, elementary algebra, plane and solid geometry, upper senior high mathematics courses, and mathematics programs of the elementary and junior high school. The institute program began in March, 1967, and is repeated for new groups of student teachers four times during the academic year--once each nine weeks. Since the institute sessions can only sample the vast amount of appropriate subject matter and since they are shaped, in part, by the student teachers' immediate concerns, no two institute sessions have been identical. The result has been a satisfying blend of what the staff and student teachers feel is important.

A typical day's program, centered around a subject matter theme, includes lectures, discussions, and seminars which include consideration of the latest curricular recommendations, examination of the latest textbooks, relevant teaching aids and supplementary materials, encouragement of experimentation with materials and methods of teaching the subject, and discussion of problems of math content and pedagogy that have come up during the week. Visiting lecturers, closed circuit television, and films are used. Student teachers are videotaped in a micro-teaching situation, and an individualized analysis is made. Coffee breaks and a long lunch hour encourage the student teachers to engage in individual concersations with the institute staff, other mathematics faculty, visiting lecturers and each other. Mathematics professors who are not part of the institute staff, visit the institute sessions and share viewpoints.

The supporting Secondary Mathematics Materials Center (SMMC) contains examination copies of textbooks (ranging from junior high to junior college levels) and bound volumes of the Mathematics Teacher and Arithmetic Teacher. NCTM yearbooks and other NCTM publications are available as well as similar publications from other professional organizations such as National Association for Student Teaching. Materials relating to recreational mathematics, mathematics history and research in mathematics education are included. Facilities are available for creation of overhead projecturals, film loops and video tapes, as well as for examination of samples of commercially produced visual aids.

At first, the SMMC was used exclusively by PITM participants; now other undergraduates interested in mathematics education use it frequently. Practicing teachers not involved in any of the institutes are beginning to use the resources of SMMC as individuals or faculty groups for their own professional advancement or curricular improvement. The PITM staff is available to them for informal consultation.

Feedback from past and current participants is encouraging. Former institute members are returning or writing for information relevant to their present positions. They are attending professional meetings, and some have returned to institute sessions to share their experiences as beginning teachers with current

participants. Student teachers in the institute are trying innovations in their classrooms, engaging in discussions with their high school supervisors concerning use of modern textbooks, and checking out materials from the SMMC to share with their supervisors.

N.S.F. officials have expressed concern that, in the midst of concerted effort through institutes to retrain practicing mathematics teachers, we continue to graduate teachers who are shortly in need of formal retraining. Our goal would be to have a preservice program in which potential teachers could be brought to the frontier of current aspects of mathematics education and encouraged to remain on the frontier by experience in creative processes and access to current information; such a teacher should not need retraining soon.

More details of the PITM and the SMMC will be available during sessions of the Chicago NCTM meeting and in a forthcoming article in the Mathematics Teacher. (PP. 371-3, April 1972).

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AN EXPERIMENTAL PROGRAM TO IMPROVE THE UNDERGRADUATE PREPARATION OF SECONDARY SCHOOL MATHEMATICS TEACHERS

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Surely everyone who works with preservice education courses and programs is continually revising and improving his course or part of the program. There comes a time, however, when major changes are instituted in response to strongly felt needs and pressures. In particular, the need to work in "real world" situations as opposed to "theoretical boxes" has been the battle cry of undergraduates for some time. Two years ago in response to this plea and upon the realization of the faculty that "talking about" teaching was not satisfactory, a feature was added to the preparatory program for secondary school mathematics teachers at the University of Missouri-Columbia. The program now provides the opportunity to gain actual classroom experience with a small group of junior high school students in conjunction with the regular secondary mathematics methods course and prior to the regular student teaching experience.

The mini-teaching experience is structured to provide at least four major benefits. First, the "clinical" approach allows the prospective teachers to know their pupils and thus to recognize that each pupil is different, both academically and socially. Second, it provides a needed setting in which experience related to the teaching procedures and classroom management techniques presented in the Special Methods course can be gained. Third, since the mini-teaching experience is done concurrently with the Special Methods course many authentic teaching problems can be brought up as examples for discussion in the methods class. Fourth, the program is beneficial to the junior high school students involved since the special attention they received in a small instructional group could not be duplicated under normal classroom conditions.

The Special Methods for Teaching Secondary School Mathematics course is taken by mathematics majors at the University of Missouri-Columbua during the junior or senior year. The students in the special methods class may register concurrently for the mini-teaching expreience in the University Laboratory School. Students who elect this exprience are given two semester hours of credit on a pass-fail basis. Following an orientation each student is assigned to teach a group (3-6) of junior high (either seventh or eight grade) pupils mathematics for eight weeks. Class periods are 55 minutes in length and meet daily. During this period the student is responsible (with supervision) for presentations, instructing, assigning, testing, evaluating, diagnosing, remediating and other facets of teaching.

This mini-teaching experience is not a required part of the professional education program. In fact, current facilities at the Laboratory School prohibit expanding the program to accommodate more than 16 students each semester. From 12 to 16 students have elected

to participate in this mini-teaching experience each semester. The mathematics education faculty and the University Laboratory junior high mathematics teachers work cooperatively in assigning students to groups.

The orientation for the mini-teaching experience is handled cooperatively by the junior high school mathematics teacher at the Laboratory School, the Director of the Laboratory School, and the mathematics education faculty. Supervision of the mini-teaching is shared by the junior high teacher and the mathematics education faculty. The only additional facilities required for this program is classroom space. Currently several groups are assigned to classrooms, with additional groups using space in the library and cafeteria. Since facilities are limited and supportive materials (such as chalkboards) are either poor or in short supply there are many acute problems that need to be resolved.

No effort has been made to collect objective evidence related to the effectiveness of this mini-teaching experience. However, at the end of eight weeks each teacher has been asked to evaluate their experience and to identify strengths and weaknesses of the program. This feedback has been used to modify the orientation session as well as the supervision.

Subjective evaluation from prospective mathematics teachers and the junior high pupils has been favorable. Pupils appreciate the opportunity to lean mathematics in a small group format. Although each teacher has experienced some "difficult days" their post mini-teaching reactions have strongly endorsed this experience. An informal follow-up of some of these students during their student teaching showed strong support of the mini-teaching experience. The students who had participated in the mini-teaching felt much more confident in handling classroom problems that arose during their student teaching. The relevance of this experience is supported by the fact that over 60% of the special methods students elect to participate in the mini-teaching experience.

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SECTION SEVEN

PROMISING PRACTICES IN FIELD EXPERIENCES FOR SECONDARY TEACHER EDUCATION PROGRAMS

The following eleven papers describe innovative arrangements with school districts which provide field experiences for pre-service secondary school teachers. Many of these programs also include specific work in methodology.

A MATHEMATICS TEACHING PRACTICUM

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The purpose of this paper is to summarize one component of Stanford University's Secondary Teacher Education Program. The program is a twelve-month, fifth-year program that leads to a California secondary teaching credential and, in most instances, to a Master of Arts degree in Education. The program was designed for college graduates in the humanities and sciences with little or no course work in professional education. It begins in the summer quarter with intensive training in the processes of teaching and is followed by an academic year during which students engage in course work in their major fields and in professional education while teaching part time in an internship position. In the past, the summer program included a formal microteaching clinic where trainees taught brief lessons to small groups of paid high school students. These sessions were videotaped for follow-up review and critique by the trainee under the guidance of a University supervisor. This aspect of the program was discontinued during the summer of 1971 and various alternatives were tried by different curriculum areas. This paper will describe an alternative practicum component designed for the pre-service trainees in mathematics.

The basic assumption on which the practicum was based is that the best initial preparation of perspective secondary school mathematics teachers whol hold a bachelors degree or its equivalent in mathematics is to place them in actual teaching situations and to provide support, encouragement, criticism, and opportunities for interaction with other trainees and with experienced teachers. In designing the practicum, the following were seen as general objectives:

> to expose the trainees to as many aspects of high school teaching as possible, giving them practical experiences to which they could later relate the courses they would take in psychological and sociological foundations of education, in curriculum and instruction, and as electives;
>
> to provide trainees with as many opportunities as possible for observing different classes, teachers, and school settings;
>
> to give the trainees experience in and responsibility for teaching single individuals, small groups of students and entire classes -- this experience to include curriculum planning and evaluation;
>
> to give the trainees experience working in as wide a variety of mathematical contents as possible and with students with as wide a range of abilities as possible;

to provide encouragement, advice and support in their experiences; and

to develop in each trainee a sense of identity with the other trainees and an atmosphere of open-communication among trainees, school personnel and University personnel regarding teaching styles, strategies, problems, etc.

In the spring of 1971, school districts local to Stanford University were approached as possible sites for the summer practicum. Discussions focused on what, if any, arrangements could be made that would be beneficial both to the school districts' summer mathematics offerings and to the eleven mathematics trainees who had been accepted to the program. The school districts viewed the trainees as providing assistance for their summer session mathematics teachers and left the final decisions of whether or not to participate in the joint venture up to them on an individual basis. Follow-up conferences were held with individual teachers and it was found that almost all were quite receptive to having trainees as assistants and were also very open to providing them with major responsibilities in the teaching of the class.

Two components emerged in the design of the practicum, one consisting of junior high school experiences and the other consisting of senior high school experiences. One school district in particular desired its junior high school Arithmetic Review offerings to be taught with as much small-group instruction as possible and the summer school Dean encouraged his teachers to participate. This junior high school program was chosen as the entire first component of the summer practicum. The offerings consisted of two Arithmetic Review classes designed to improve students' skills in arithmetic and one class in the Fundamentals of Modern Mathematics designed to familiarize students with modern mathematics concepts. The trainees were divided into two groups of five and six, and each group was assigned to full participation for three weeks in an Arithmetic Review class. The specific objectives for this assignment were to familiarize the trainees with students of less than average ability in mathematics, to give the trainees experience with working with mathematics content at a computation level, to give the trainees experience with working with individuals and with small groups of students, and to give the trainees as many degrees of freedom as possible with respect to a teaching situation. During the three weeks, the trainees were also assigned as a group to the Modern Math class. Here each group was responsible for a topic to be presented and each member of the group was to present to the entire class one aspect of the topic. The specific objectives for this assignment were to give the trainees experience in curriculum planning, development and evaluation, to give the trainees experience in teaching an entire class of students, most of whom were of average ability in mathematics, and to give the trainees experience working with mathematical content at various cognitive levels.

The second component of the practicum consisted of two high school teaching experiences. Five high school classes, each meeting four hours per day for eight weeks, were selected. Four of the classes, one General Mathematics, two Algebra I, and one Algebra II, were all in one school district and the other, a large team-taught Geometry class, was in a different district. After the first t

weeks' experiences were completed in the junior high school classes, a pair of trainees (one from each of the original two groups) was assigned to each of the first four high school classes described above and the remaining trio was assigned to the team-taught Geometry class. After two weeks, new pairs were formed and new assignments made. The specific objectives of these assignments were to give the trainees teaching experience in two different areas of secondary mathematics curriculum and with two different teachers, to give the trainees exprrience working with high school age students and to give the trainees experience working with a set curriculum during a specified time interval.

On registration day, the trainees were informed that they were to report to a local junior high school the next morning at 7:00 a.m. There they were told what class they were assigned to and were asked to sit in and observe. During the class the teacher did some lecturing and then gave the students assignments to work on. The trainees were asked to move freely among the students and to help them. After the class the trainees, teacher, supervisors, Stanford advisor and the Dean of the summer school met to discuss what could be done to improve the mathematical performance of the students. The trainees were given center stage and asked what suggestions they had and what they would do under the present circumstances. Notions of diagnostic testing, individualizing instruction, ability grouping, motivational techniques, objectives, and evaluation were all brought up by the trainees. Through questioning and discussion, an initial plan of action for the three weeks was set up for each class. In both Arithmetic Review classes the trainees made the major curriculum and management decisions with the support and assistance of those mentioned earlier. Students were tested, grouped according to ability and instructed in those areas of arithmetic in which they were the weakest.

The trainees also took full responsibility for their topics in the Modern Math class. After the general topics were determined by the teacher involved, each group of trainees developed an outline of what they wanted to present, who was to present each section, or sections, and what methods they would use for evaluative purposes. Each trainee then took full responsibility for developing his section, keeping the advisor, teacher, supervisor and others of the group informed of his progress. When the sections were in final form, they were taught to the class. Immediately afterwards, the trainee met with all who had observed the presentation and the lesson was critiqued. The mathematics department office served as headquarters during this component. Trainees met there each morning at approximately 7:00 a.m. to discuss their plans for the day's classes. The full morning was spent working in the assigned Arithmetic Review class for two hours and teaching or observing in the Modern Math class or planning or evaluating past or future units, lessons, or tests during the remaining time.

The schedule during the senior high school component was similar, with the trainees working more independently since they were assigned two or three to a class. The trainees were responsible for a minimum of two of the four hours of each class period and spent the remainder of the morning either preparing future lessons, observing other classes, or meeting with their supervisor, advisor or teachers to critique their performances.

Throughout the practicum, there was constant communication between all involved. Experiences ranged from learning to operate a ditto machine to philosophical discussion over coffee on the rationale for education in general and mathematics in particular. Trainees spent the afternoons on the Stanford Campus taking courses in mathematics and/or education. All trainees enrolled in a Curriculum and Instruction course taught twice weekly by their advisor. Here general topics were discussed, usually motivated by the practicum experiences. The trainees kept journals of their experiences and their reflections on them, sharing them with their advisor and supervisors for reactions and comments. The cooperative spirit that was born and nurtured during the practicum continued into the academic year. Although the trainees became interns in different schools, their sharing of ideas and problems and their observations of each other continued.

In an effort to evaluate the practicum experiences, information was gathered on its effects. The teachers and administrators involved provided continual feedback during the practicum and at the conclusion were asked for specific evaluative comments. All saw the practicum as an important part of their programs and looked forward to continued cooperation in future summers. Students' reactions were obtained at the end of each experience, providing specific feedback for the trainees as well as general evaluative information. When students in the Arithmetic Review classes were asked on a questionnaire whether they would like to take another mathematics course like their summer class, over seventy percent said yes. Comments on what aspects of the class were enjoyed the most were also asked for. Over thirty percent of the students mentioned the small group structure. The trainees themselves provided information both through their daily journals and through individual conferences held at the completion of the practicum. Midway through the next academic year, the trainees, now interns, were asked to reflect on the practicum exprrience in the light of their teaching experiences and completion of two quarters of course work. The practicum was seen as invaluable in their preparation and most claimed it was the single most important aspect of their program. Other comments also supported the assumption on which the practicum was based.

Overall, the summer practicum for the mathematics trainees was regarded as one of the most successful alternatives to past experiences. In light of its success, arrangements were made to extend the model to other curriculum areas.

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MATHEMATICS EDUCATION PROGRAM

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Mathematics education majors at Florida Technological University have several unique features in their program. The most important is early and continued exposure and experience with public school pupils. This includes tutoring, serving as a teacher aide, and student teaching. The major philosophic point is to blend theory with practice. The mathematics education major has contant supervision by a college professor who works directly with the public schools and in the college classroom as well. Another feature is the specially prescribed course sequence, designed for the needs of a public school teacher--the emphasis is a broad base of mathematics courses, foundational education courses, and mathematics education courses.

The FTU program in secondary mathematics education is divided into three phases. Phase I, which is taken late in the student's sophomore year, or early in the junior year, is the student's first contact with education courses. The phase consists of two courses:

1. Human Development (3 qh) - in which the growth of a child is traced from birth through adolescence.
2. Teaching Analysis (5 qh) - consisting of five basic areas of coverage - writing objectives, planning units and lessons, questioning techniques, analysis of verbal and non-verbal interaction in the classroom, and socioeconomic variables.

   In addition, each student visits a public school at least fifteen (15) hours during this quarter to tutor. The experience is usually in a disadvantaged school. Each student is video-taped at least once during the quarter as he is teaching a lesson.

Phase II, junior year student teaching, is taken for one quarter at some time in the junior year. In this quarter, the student spends one-half day, four days a week, in the public school as a teacher aide. In this situation, the student is an assistant, his major responsibility being to carry out tasks prescribed by a professional. The student is visited at least once a week by a resident (part-time) college teacher, and the student is also observed periodically by the content specialist from the University. For the other half day, the Phase II student teacher is enrolled in one of four classes:

1. Secondary School Curriculum
2. Evaluation (test construction and evaluation, and simple statistics)
3. Learning Theory
4. Mathematics Instructional Analysis (methods and content)

Phase III consists of a quarter of full-time teaching except for the first two weeks in which the students meet on campus for a half day each day to discuss the planning of their lessons, construction of audio-visual aids, investigation of available equipment, etc. They are also enrolled in a class which meets one evening a week and is designed to serve as a discussion period for their problems in school, school law, liability, professionalism, etc.

Between these phases, the student is required to take at least fifty-nine (59) hours of mathematics, including computers, calculus, analytic geometry, euclidean, non-euclidean, and projective geometry, number theory, linear algebra and probability and statistics.

Furthermore, a strong emphasis is placed on mathematics laboratory situations. We have established a mathematics laboratory in Oviedo High School and in Union Park Junior High School. Each mathematics education major participates in the lab in his junior year teaching phase. Emphasis is placed upon the advantages of laboratory methods, versatility of the lab approach, and inspection and development of laboratory experiments. These experiments are to stress the relevancy of the situation to the everyday lives of the students. Obviously, many of these lessons will be "discovery" based.

The program has been cooperatively developed by many specialists and is changed as the need arises. The number of participants has grown to forty-five (45) seniors in mathematics education as the University begins its fourth year of operation.

Students are evaluated in many ways in their student teaching experiences. The evaluation input comes from the public school directing teacher, the assigned coordinator for the public school from the University and the content specialist. An attempt is made to video-tape each student at least once during the senior year teaching experience and use the tape as an instructional device.

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AN IN-SCHOOL LEARNER CONTROLLED TEACHER TRAINING PROGRAM: MATHEMATICS--A COMBINED SCHOOL-COLLEGE PROGRAM

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Campbell Junior High School

Public School education must change. There is much talk today of changing the elementary schools, talk of open schools, schools with students taking a more active role in the learning process: schools responsive to student needs and differences. We hear about radical alterations of the learning environment and the changing roles of students and teachers in light of the needs of society and advances in technology. All of these suggestions lead in the general direction of some form of individualized instruction to maximize student growth.

But what of the secondary schools? Are they to remain static amidst all this? This study is an attempt to make a modest beginning in mathematics in the secondary schools by establishing a teacher training program based upon individualized instruction; not a program that isolates trainees from each other, but rather, one which encourages work with fellow students in a mutually productive manner, employing the latest media as needed, and establishing an active role for the trainee in planning, evaluating and carrying on activities which will lead to learning.

Undertaking such a program implies three major assumptions (among others).

1. Teacher-training must itself be a model for the kind of learning environment the future teacher is to create.
2. The effort must be a combined school-college one, based in the school, with the staffs of each as equal, participants in its planning, development, implementation and evaluation.
3. Teacher certification in mathematics should be based upon performance rather than course work.

At the start a group of 20 volunteers (math majors) registered for special sections of Education 10 and 62.1 in Fall, 1971, and Education 73.1 in February, 1972. These are the psychology, methods, and student-teaching courses.

Instead of regular course work and field work, the group reported to the learning laboratory at Campbell Junior High School. There they underwent an orientation session and were

organized into 5 study groups of 4 to 6 trainees each. A mathematics teacher at Campbell Junior High School acted as instructor-adviser to the group.

The one year block of time is being utilized to provide experience in three areas without regard for course structures in an attempt to provide opportunities to explore questions that will involve them in three areas as follows:

Area A: Cognitive

The learning laboratory located at Campbell Junior High School consists of collections of materials in a variety of media designed to enable trainees to move at their own pace through their study groups. The laboratory is generally open to all trainees except for special lectures or demonstrations undertaken at student or staff request, growing out of special needs that develop. Campbell Junior High School staff has access to any of these activities. Special hours are established when expert assistance is available to trainee groups (Q.C. or JHS 218 staff member, outside expert, etc.) that request assistance. This may take the form of individual or group conferences, lectures in a given area, special demonstrations, etc. Proficiency will be demonstrated through pencil and paper tests, term papers or any other appropriate means. The New York State Proficiency Test in this area is a possibility.

Each group conducts an evaluation and planning conference with the director and group instructor weekly. Proficiency in a given area may be established at any time. The areas of proficiency are determined by staff and trainees jointly.

Area B: Affective

Each group is requred to meet a minimum of one hour per week with a staff member of the Queens College Education Clinic, in a discussion group. This experience will continue throughout the year, becoming voluntary in the second semester.

More such sessions may be held upon trainee request, in addition to special demonstrations involving junior high school students. The goal is to help each individual to achieve greater self-awareness in terms of expectations, attitudes and feelings towards self, school, students, minority groups, etc.

There is no evaluation as such (excepting research purposes) to assess individual growth or change. However, decisions relative to continuation of preparation for teaching may be influenced by the outcomes of these sessions and the problems generated therein.

Area C: Performance Criteria

Here trainees, staff (both Q.C. and JHS 218) meet and undertake to identify what an effective teacher of mathematics must be able to do in specific terms.

First, broad categories of proficiency areas are established such as planning, motivation, etc. Each category then is broken down into component parts small enough and specific enough so

that each person in each study group knows exactly what is expected in working with children, i.e., teach a single concept in 10 minutes without answering a question except with another question.

The development of systematic means of observing whether or not proficiencies have been established is an integral part of these experiences. (Flanders scale, OSCAR, etc.)

Once the list of performance criteria has been established the trainee and his study group undertake to achieve proficiency first through a series of simulation experiences:

interacting with taped video lessons
use of simulation kits (i.e. SRA,
role-playing in group
classroom observations

and then with in-action experiences through

work with a single student
work with a small group of students
a regular classroom situation.

Each trainee takes as little or as much time as is needed to reach the established proficiency level previously defined. Upon satisfactory completion of

1. Proficiency in all cognitive areas
2. Attendance at a minimum number of self-awareness sessions
3. Proficiency in a minimum number of performance criteria

the trainee receives credit for Education 10, 62.1, and 73.1, a total of 13 credits. Upon award of the Bachelor's degree the trainee will automatically be recommended for provisional New York State certification in secondary school mathematics and will be qualified for the New York City examination.

The program is currently going through an exploratory phase to be followed by a year of carefully controlled experimentation. All the experiences of the program are open to question and it is expected that the resulting second year program will differ greatly in form from this pilot phase. Some of the questions under exploration are:

1. Are the trainees capable of establishing their own behaviorally stated objects in the cognitive and performance areas?
2. Does student involvement in setting criteria influence the quality of teacher-training?
3. What role does each component of the program play in the teacher-training process? i.e.
   a. Do the self-awareness groups influence the trainee in the affective domain?
   b. Does arranging trainees in small study groups facilitate trainee development?
4. Will the trainees completing the program be more inclined toward adopting student-centered activities in their secondary school classrooms?

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A MATHEMATICS SYSTEMS LABORATORY FOR TEACHER TRAINING

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The training of secondary mathematics teachers at San Fernando Valley State College had historically involved students taking courses in mathematics content for four years followed by a fifth year of professional training. This led to a state credential and in some cases the beginning of a master degree. This fifth year included methods and student teaching in mathematics, which was generally done in the Los Angeles City Schools. To bring innovation into this program was almost impossible for the following reasons: a) the college methods professor had in most cases been away from the secondary classroom as a teacher for many years; b) the college classroom contained few, if any, materials considered important in teaching kids; c) very little interaction between the public school teacher, college mathematics professors, and teacher training personnel; and d) no way to try out an approach in the classroom and get immediate feedback. The total situation was so "boxed in" that innovations could only be talked about and suggested, never really demonstrated and evaluated. In short, the problem was seen as a failure by the college to provide leadership in bringing about innovation in teacher training to produce mathematics teachers skilled in the use of labs, computers, etc.

Having identified the problem it was felt that a better teacher training program could be developed by more effective use of college and school personnel. The proposed program would be completely housed in the public schools. Methods classes and seminars would also be conducted on the school grounds. A complete mathematics laboratory would be developed wherein student teacher, master teacher, college professors, and administrators would learn together.

This program, now funded under EPDA and known as Trainers of Teacher Trainers (TTT) consists of three mathematics laboratories, two in junior highs and one in a senior high school. One school is predominately black, one is brown, and the third is largely white. Each lab contains a staff development room, an activity room, and a computer room. All students taking mathematics are involved in this program to the extent the teacher wishes. The mathematics content ranges from simple arithmetic to advanced placement courses. Student and master teachers are now deeply involved in preparing curricula that use the math labs and computers as an integral part of their course. Curriculum development is viewed as an ongoing process, to be modified to some extent by every student teacher that passes through the program. Informal seminars are conducted almost daily at the school sites.

During 1970-71 two junior high schools were involved for a total of about 2500 students in grades 7, 8, and 9. This year a high school has been added with about 2300 students in grades 10, 11, and 12. Master teachers at the three schools number 18 and there are approximately 24 student teachers per semester. College staff varies in number.

This program was designed three years ago by a group of college and public school teachers. Administrators in both systems have endorsed the program to the extent that it will now be expanded as an in-service feature for other public schools in the area. With the freedom and flexibility that has been available the program is in constant state of change. Consultants from many different colleges and schools have also added valuable ideas to the program.

Each of the three labs contains equipment and material for a variety of activities plus calculators and time share computers. Over 60 kits are now in use, with new ones being prepared constantly. The typing problem with terminals was solved by going to optically scanned cards that are marked with pencils. This approach has greatly extended the use of the computer resources. To date the program has cost about 60,000 dollars per year, of which very little has been needed for salaries. Also this has included the purchase and/or lease of equipment that has capability of being used for many years. No one is paid full time under the grant. It should be emphasized that this program was developed to continue after funds from the government run out.

The major emphasis has been to keep the existing mathematics program, but improve the techniques of teaching it. At the junior high level the content is largely determined by the California Strands Report and the senior high is quite traditional. Some content innovations are being developed in the general area of applications of mathematics to non-professional jobs. Activities center on lab lessons with manipulative devices, games, kits, constructions, etc.

Extensive data was collected on junior high students during 1970-71. This was used by the college merely to demonstrate that this program in no way caused junior high students to learn less mathematics. For example, last year's incoming seventh grades gained 2.5 years on basic skills.

In getting at the effectiveness of the program as a teacher training experience several evaluations were conducted. California Teachers Association (CTA) was hired to evaluate the total program. The findings of this evaluation are much too extensive to be included here. However, their summary remarks, found in Special Research Report, No. 71* state: "There was general consensus that

*California Teachers Association: Research Dept. Evaluation of 1970-71 San Fernando Valley State College Trainers of Teacher Trainers Project: Special Report No. E-71. Burlingame, California. August 1971.

the main strengths of the program lie in several areas. These were:
1. The team approach and excellent interaction of the staff;
2. The development of new and exciting ways to teach mathematics;
3. The increased interest and enthusiasm shown by students; and
4. The excellent resource materials, equipment and facilities.

In addition, several studies were conducted by the author to get student teacher's reactions. One of these studies involved comparing classroom lessions with lab lessons. Student teachers were asked to rank in order of difficulty problems they had in lesson planning. The results were: (1 being the most difficult)

	Classroom Lesson	Lab Lesson
Selection of material	3	1
Organization of lesson	2	3
Scheduling of time	1	2
Making assignments	4	4

When asked to rank in order of difficulty classroom problems, the following resulted: (1 being the most difficult)

	Classroom Lesson	Lab Lesson
Evaluation of lesson	4	1
Evaluation of Students	3	2
Provision of Individual Differences	1	3
Discipline	2	4

(Note that discipline was easy in the lab and difficult in the classroom. One of these schools is in the inner-city.)

Average time spent per day in preparing (1) day's classroom lesson: 1.6 hours

Average time spent per day in preparing (1) day's laboratory lesson: 2.7 hours

Additional data is available on the effectiveness of this program. For further information, contact:

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AN EXPERIENCE-ORIENTED APPROACH TO MATHEMATICS METHODS INSTRUCTION

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This program was designed as a first professional education experience for students holding B.A. degrees in mathematics and wishing to become certified teachers. It had been our experience that persons in earlier after-degree programs seemed less than motivated to relate the experiences in the methods class to their field experiences. This was compounded by the fact that they were engaged in 4-5 courses which break twice during the year for student teaching. Thus, it was difficult to arrange for school experiences which did not conflict with other university courses.

The new program is an attempt to integrate school and methods course experiences. It is predicated on the assumption that discussion of methodology must have a basis in experience derived from schools, peer teaching or vicariously through observation of video taped models. The program had three components: the methods course, student teaching and other school experiences.

The term began with students spending two days in secondary school mathematics classes during which time the students were asked to assume some teacher roles. This experience caused a state of disequilibria in that the students' conceptions of teaching were seriously challenged. During three following weeks intensive curriculum and methodological work occured; this consisted mainly of cycles of peer micro-teaching and a curriculum seminar during which the curriculi at the senior high school level were studied. The students then spent 3 weeks in large urban high schools with one half day/week devoted to methods seminars.

During the seventh week of the course, the class convened in two small towns. During this week students spent half days in elementary classrooms and half days in secondary schools. There were nightly planning and discussion seminars with teachers, school administration personnel and the methods instructor. The purpose of the week was to experience teaching in a non-urban setting and to see teaching within the context of a whole system.

The eighth week was an intensive method week with emphasis on mathematics labs, individualized instructional methods and audio-visual materials. Again micro-instructional experience was used as the students met in day-long sessions.

The second three week block of student teaching and seminars took place in urban junior high schools. This was followed by a student designed school experience week. In this week the students

could extend their previous student teaching or design special student teaching programs, say with mathematics labs or individualized instruction. They could spend the week in special environments such as in mathematics classes in a special vocational school for slow learning students or in mathematics classes at the school for the deaf. Another option was to teach mathematics at a different level, e.g., with primary school students or with gifted Grade 12 students.

The objectives for the program were in many respects student developed in that there was a wide range of options in terms of the particular experiences that they pursued. But the overall program was guided by a competency list called Behaviors of a Mathematics Teacher. (Kieren, 1971) An example of one section is given below:

Listed below are a large number of possible competencies of a mathematics teacher. While some of the statements are more general than others all are oriented towards actual things you as a beginning teacher can do. During this course you will have experiences which relate to these behaviors. You will have opportunities in class, in microteaching sessions, in school classrooms and in interviews to exhibit at least some of these behaviors. You might use this list as a checklist and match your experiences and your class and teaching work against it. Clearly, you will not be able to exhibit all of these behaviors or be very good at many of these in the course of this term. Nonetheless they are a set of competencies which will contribute to your performance as a teacher. In this sense it represents a set of goals to which you can add and by which you can evaluate your own behavior as a mathematics teacher.

I. Lesson development of groups of students (25 - 30)

A. In designing lessons the teacher will be able to:
   1) write behaviorally stated objectives which are:
      a) content oriented in terms of skills or techniques, concepts or structural development
      b) process oriented in terms of students' mathematical "Knowhow": guessing, hypothesizing, evaluating, symbolizing, aximotizing, etc.
   2) write evaluation items or settings to these objectives
   3) describe or match teaching behaviors and objectives
   4) properly place lesson objectives in a sequence of course objectives

E. Question sequences
   1) The teacher will be able to list the characteristics of:
      a) factual recall questions
      b) concept development questions
      c) soft challenging questions
      d) hard challenging questions

   and give the intended effects on students' behavior
   2) The teacher will be able to design a question sequence and predict its effect in terms of the quantity, quality and extent of student behavior.

Other sections of this list dealt with Curriculum, Materials and Special methodologies, Individualizing Instruction, Problem Solving Instruction, Evaluation, and Professional activities. In all the list contained well over 100 competencies.

Results

What were the results of this program? In general, there was a high level of student performance and positive response. Harvey and Kieren (1972) compared students attitudes and performances with those of students in after degree programs in 1970-71. The students in the new program had significantly better perspective of teaching than the students the previous year. In addition, the students related directly more of the methods topics to their teaching and felt less frustration with methods.

Thus there is evidence that the experience-oriented program had several positive effects on after degree pre-service teachers.

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COOPERATIVE MATHEMATICS PROGRAM FOR THE TRAINING OF TEACHERS OF SECONDARY MATHEMATICS

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The Mathematics and Teacher Education Department of Western Michigan University, in coordination with the Kalamazoo and Portage Public Schools, have developed an innovative program for the preparation of teachers of secondary mathematics. The design for this program is based upon the following premises.

> Skill in teaching can best be developed through a controlled sequence of tutorial, small group, and total class instruction of target age pupils.
>
> The professional sequence of courses provided by the Mathematics and Teacher Education Departments are more meaningful to prospective teachers if they are conducted concurrently with field experience.
>
> The problem of relating and communicating with young people in different school environments, an ability so crucial in present day classrooms, should not be left unattended in the University program.

A pilot project was conducted during 1971 to test the feasibility of this program. These explorations, in addition to meetings with the administration and professional staff of the local systems, have revealed an active interest to participate in the pre-student-teaching development of teachers of secondary mathematics. Two schools from each of these systems are participating in this program during the present semester involving twenty-six university participants.

The design of this program is due, in part, to the author's experience with experimental projects in teacher education developed at Ohio State University.

Listed below are those goals of the program which were unattended under previous curricular offerings for secondary education mathematics majors at Western Michigan University.

> To develop sensitivity for the needs and interests of the junior high school student in interaction with his environment.

To develop skill in self analysis of verbal teaching behavior.

To develop familiarity with the teaching profession in relation to different school environments in order to provide for a reasonable career choice.

To develop the ability to communicate mathematical ideas in a manner comprehensible to the student at a lower level of mathematical maturity.

To develop skills in analyzing learning difficulties in mathematics.

To develop teaching strategies which enable the student to overcome learning deficiencies.

The following activities are designed to accomplish the aforementioned goals.

Tutorial and small group instruction in contrasting school environments (8 hours per week)

Analysis of the teaching-learning process via video and audio tape recordings.

Coordinated Mathematics Methods, and Teaching and Learning seminars (4 hours per week)

Weekly seminars conducted in participating schools with the cooperating staff and participants.

Participating students are assigned in teams of two to each cooperating teacher. Team members alternate responsibility for small group instruction in order to provide each other with daily feedback on teaching episodes. One half of the teams begin in a junior high school representing School Environment I while the other group begins in School Environment II with the groups changing assignments at midterm. This design provides continuous help for participating teachers and their students during the program.

The two schools chosen to represent Environment I are urban desegregated schools serving student populations with a wide spectrum of socio-economic backgrounds, including a sizable black minority, and Free and Reduced Lunch Subsidy rates of 13 and 18 percent. The schools representing School Environment II serve a predominantly white, upper-middle class student population, with Free and Reduced Lunch Subsidy rates of 1 and 0.2 percent.

SUMMARY OF SEMESTER
SCHOOL ACTIVITIES

Week	Group A	Group B	School Activities Class I	Class II	School Seminar
1			Observation and Assisting	Observation and Assisting	Orientation by Principal
2					Techniques of Tutoring
3					Analysis of Video Tapes
4			Tutoring and Small Group Instruction	Tutoring and Small Group Instruction	Analysis of Video Tapes
5					Analysis of Video Tapes
6					Preparation for Total Class Experience
7			Total Class Instruction		Analysis of Video Tapes on Total Class Instruction
8			Midterm Evaluation		
9-14			Teams change school environments and recycle activities described above.		
15			Project Evaluation and Administration of Post Tests.		

Environment I

Environment II

Research and evaluation are considered integral components of this program. Both informal feedback and formal evaluation are obtained throughout the program in order to discover necessary adjustments in program design.

Present research activities include the administration of attitude tests, teaching inventories, and situation reaction tests to probe the effects of activities in the different school environments in addition to testing tutored students for achievement gains. Future plans include the collection of empirical data concerning teacher effectiveness in order to test the validity of the theoretical foundation discussed in the introduction.

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USING INTENSIVE SCHOOL EXPERIENCE IN TEACHER EDUCATION

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The Faculty of Science and Mathematics Education concluded in 1968 that the then current teacher education program fit neither the changing nature of the urban schools nor the expectations and understandings held by university students. The program was revised to stress problem-solving and decision-making as characteristics of the teaching process. Early, continuing practical experience encompassing increasing responsibility was provided to establish a base for consideration of theory and to allow students to fulfill actively their social concerns.

Three years of pilot experience have affirmed our belief in the basic design of this program although the program is subject to constant evaluation and modification.

All aspects of professional education are embodied in this program. The program is designed for junior and senior students. Each professional preparation has two components which are intimately related - the theoretical and the practical. In this program, no content in education is considered without related, supervised experience in the schools. The program could not be successful without the sustaining and careful cooperation of the Columbus schools.

Video-taping, CAI and micro-teaching techniques are used in the program. Seminars are limited in size and are often held in the schools with in-service teachers participating. Saturation placement techniques are used in many schools. Other departments in the university cooperatively staff some of the seminars.

Junior Year: Having been selected into the mathematics education program on the basis of academic and personal characteristics, the first quarter junior observes the junior high school and tutors a junior high school mathematics student twice each week. This experience is focused upon the study of schools and of individual cognitive learning in seminars following the tutoring sessions. Video-tapes of tutoring sessions provide a basis for discussion. The second quarter junior studies the psychology of child growth and development and the elementary school curriculum while tutoring and working with small groups in an elementary school. Related seminars in educational psychology are conducted by members of the Department of Psychology. A total of 13 quarter hours credit is earned during the two quarters.

Senior Year: Upon successful completion of the junior program, the senior is permitted to enroll in the first of two professional quarters. The first quarter is a 17 hour pre-student teaching block

encompassing traditional methods, educational sociology and educational philosophy. The second quarter is a fulltime student teaching responsibility. A student is not allowed to enroll in other courses during either quarter.

The participant in the pre-student teaching block spends the morning in the schools and the afternoons in seminars. The school experience is evenly divided between inner and outer city schools at the junior and senior high school level. Assigned in pairs to cooperating teachers, student particpate as teacher aids, do bit-teaching activities and acquire a familiarity with the total operation of the schools. Seminar activities grow from the experiences in the school. The contrasting school-community environments naturally direct seminar discussions toward using sociological information in planning for teaching and in making curricular decisions. The talents found in several departments of the University, in the schools, and in related community agencies are focused in seminars on contrasting the school-community environments and their impact on the larner in the schools. These experiences are designed to help the prospective teacher consider teaching as a scientific decision-making process in which he uses the nature of mathematics and his knowledge of the major, unifying concepts of mathematics in designing instructional strategies. Throughout the quarter the undergraduate is helped to consider systematically those conditions of the learning situation over which he has control and those which he does not.

During the student teaching quarter, the prospective teacher is assigned fulltime to a junior or senior high school. This will frequently be with a cooperating teacher with whom the student has worked in an earlier segment of the program.

Evaluation is carefully designed into the program as a major component. The student not only assesses his own performance as he assumes increasing instructional responsibility, but he is evaluated by at least six other individuals. This evaluation is used in two ways. First, it provides diagnostic information to help the student modify his behavior. Second, it provides a base for excluding non-performers from student teaching and, ultimately, from certification.

Students acquire a 75 hour comprehensive major in mathematics with no teaching minor. Twenty hours of the major are in an application area; usually a behavioral, life or physical science. Students must acquire twenty hours of analysis, ten hours of algebra, and five hours each of history of mathematics and geometry. Students elect either a probability course or a computer science course. In meeting the University liberal arts requirement, all students enroll in a logic course in the philosophy department. This course is not part of their major.

The enrollment in the junior portion of the program in fall quarter, 1971, was 82. Seventy-five seniors will complete the program this academic year. Newly implemented enrollment limitation procedures establish a quota of 55 graduates of this program per year for the future.

Conservative estimates of cost to the University indicate an increase of 20% per student unit over the previous program. This

factor derives from the increase of supervisory time in the schools, the associated travel costs and the small numbers in seminars. Cost to the participating school is not reflected in the above figure; however, saturation placement techniques are used to provide service to the schools in meeting their instructional responsibilities. For any given quarter, five or six doctoral student teaching associates work approximately 20 hours per week in this program. At least four professors of mathematics education are engaged full or part time. The Department of Psychology and the Department of Curriculum and Instruction assign staff members to the project two quarters of the year. During their senior year students are assessed a $35 fee to cover materials and travel.

Innovative Features:

1. Totally experienced based.
2. Contrasts school-community environments.
3. Utilizes saturation placement techniques in assigning participants to schools.
4. Makes effective use of the knowledge of in-service teachers.
5. Participants have teaching experience at all levels - elementary, junior high school and senior high school.
6. Evaluation of participants is comprehensive and includes performance. It is used as a diagnostic aid and to select non-performers out of a certification program.
7. Prospective teachers are provided a variety of teachers to model.
8. Prospective teacher educators (graduate student employees) acquire a broad base of experience in both in-service and pre-service education.

Teacher education does not provide a good base for research yielding definitive results because of number and design problems. The results stated below are tentative and, in many cases, suggestive of need for further research. Two extensive, formative evaluations are available:

Erb, Clinton, A Formative Evaluation of an Experimental Teacher Education Project for Juniors in Mathematics Education at the Ohio State University. Graening, Jay, An Evaluation of a Secondary Mathematics Teacher Education Program Emphasizing School Experiences in Contrasting Cultural Settings.
(Unpublished doctoral dissertations, Spring, 1971)

1. Psychology approaches the status of being a tool rather than an academic exercise for undergraduates.
2. Tutoring by juniors has had a desirable impact on junior high school students achievement.
3. The student teaching experience provides a problem in teacher education. Whether in a traditional program, student teaching tends to damp enthusiasm and idealism. Certain types of cooperating teachers appear to have a greater damping effect than others. For example, teachers with an applied rather than a pure mathematics orientation tend to damp idealism more.

4. School personnel enjoy the responsibility of teacher education and have felt the program contributes to their instructional responsibility.
5. A greater percentage of students matriculating in this program seek junior high school and/or inner-city teaching positions.
6. An unusual amount of administrative detail is necessary to operate this school-based teacher education program.
7. Students select themselves out of the program early rather than waiting until well into student teaching, the point at which they have too much committed to education to withdraw freely.

This approach to teacher education raises many researchable questions to which we need answers. Continued evaluation is being conducted by the staff. A follow-up study of recent graduates is anticipated.

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Note: This program was awarded a Certificate of Recognition by the American Association of Colleges for Teacher Education at its annual meeting, February, 1972.

AN INTRODUCTION TO TEACHING VIA AN EARLY TEACHING EXPERIENCE

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The general objectives of a professional education curriculum should be three-fold. It should acquaint the prospective teacher with the problems and the challenges of teaching; it should provide him with the necessary skills to help him meet these problems and challenges; and, it should provide the educational institution with the opportunity to evaluate him as he meets and reacts to these problems and challenges. The project described here is an attempt to provide the prospective teacher with an introductory teaching experience early in his college career.

It is the belief of this writer that teaching cannot be learned vicariously, but must be learned through experience. Therefore it seemed reasonable to suggest that a carefully designed and controlled teaching encounter, instituted early in the student's college career, would be of benefit in attaining the objectives of professional education.

At the University of Illinois, the prospective secondary teacher is introduced to the professional education curriculum through a two semester hour course offered at the sophomore level. All of the enrollees are mathematics majors, and most will have completed the calculus sequence by the time of enrollment. This course was used as the vehicle to provide the early teaching experience, using the "mini-teaching" format, wherein each student teacher teaches four or five students in a controlled setting.

The program was begun in the spring of 1971, and has been revised continually since then. During the first two semesters of operation, the student teachers worked with 4th, 5th, and 6th grade mathematics classes in a local elementary school.

The children were divided into groups of four or five, with four student teachers assigned to each of these groups. With two teaching sessions per week, each student taught or observed once per week, although many of them came to additional sessions to observe.

Initially, each student was given a great deal of latitude in the choice of topics to teach. The Arithmetic Teacher provided the bulk of the topics, with additional choices being suggested by the Nuffield Project and the Madison Project. After the first semester's experience, it was decided that everyone should teach the same topics. This change was made in an effort to reduce the number of pedagogical problems facing these student teachers, and to give the children involved a more uniform experience. The UICSM Motion Geometry Course was chosen and selected topics were taken from it.[1]

Due to scheduling limitations, it was necessary to meet with the student teachers in small groups, rather than with the class as a whole. This proved to be a blessing in disguise, as the more personal interactions enabled both the author and the students to become more aware of the situations each individual faced. It is felt that these sessions have constituted a necessary segment of the program, and they must be continued in the future.

In the spring of 1972, this course will be combined with another to become a four semester hour course. This is scheduled to meet twice a week for two hours per session. This course is to be divided such that two hours will be for lecture and two hours for laboratory. Because of these changes, it is planned that the students will teach in junior high school classes rather than in the elementary school

After an initial orientation period, in which the students are introduced to the topics which are to be taught and to the general philosophy of the course, all of the remaining class sessions will be held in the junior high school class rooms rather than at the University.

The first half hour of each class session is to be devoted to the introduction of new concepts and planning of the teaching sessions. The next hour is to be spent in teaching the children, with the remaining half hour to be spent in reviewing the day's experiences.

During the teaching segment of the class, each student will observe for a half hour and teach for a half hour. As with the elementary children, these children will be divided into small groups but with only two student teachers assigned to each group. Therefore, each student teacher will teach two times per week and observe two times per week. Again, the topics to be taught will be taken from the Motion Geometry Course.

The results of teaching the course in this manner have been varied. The interest and enthusiasm of the college students has been high. They have been very conscientious in their lesson preparations and in their work with the children. Based upon this experience, some of the students have decided that they would rather not continue in the teacher education program. Others have decided to change to the elementary teacher education program. Many of the student teachers had never received instruction in transformational geometry, so this was a new approach for them also. In addition, the problems raised in attempting to teach 'simple' concepts to the children caused many to re-examine their own mathematical background.

The children involved received instruction on topics to which they had never been exposed before. The transformational approach was one which they could readily grasp.

While it may be argued that this is not a realistic situation, it must be remembered that in a laboratory situation, many of the variables are controlled in order that others may be studied. In this case, the student teachers were able to concentrate upon a few students without having to be concerned about the other problems that a regular class presents.

This sort of program may be adapted in many teacher education programs. It does require more of the instructor's time to operate, but the benefits which may be derived from it justify this expenditure. It does not require any additional outlay for equipment or facilities.

What is required is a good working relationship with the local school system(s). One way to accomplish this is to be aware of their problems and be willing to help solve them. The University cannot look at this program solely as a means whereby its student teachers gain experience. Rather, it must look to the needs of the children

and determine how it can contribute to the satisfaction of these needs. In the case of the program being described here, an enrichment program was proposed whereby the author agreed to teach certain specified topics to the children.

In terms of possible research, the small group setting affords an excellent opportunity to study the interactions of teachers and students.

It would seem reasonable to suggest that each student could be evaluated in terms of whether or not he was ready to go on to another step in the "Yes, you're ready.", or a "No, not yet.", sort of decision could be made. In effect, this course serves to screen the students.

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INTERNSHIP PROGRAM IN SECONDARY SCHOOL MATHEMATICS

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Although it is over twelve years old, our internship program in secondary school mathematics has remained an innovative pre-service approach because it ahs continued to change to meet the changing needs of school districts.

Outline of Main Features of Program

1. Student enters program with equivalent of B.A. with major in mathematics.
2. Interns receive an intensive summer program of about 10 weeks work, including coursework in education and mathematics, along with practical school experience, before beginning teaching.
3. Interns receive a full salary for an entire year of high school teaching.
4. Interns return to the campus one evening a week during the academic year for a seminar. In addition, they receive college supervision in their schools.
5. At the end of the second summer, participants receive their regular credential.

Some Innovative Aspects of the Program

1. Enrollment is limited to approximately 10 students per year. The selection process includes an interview in the mathematics department. Approximately 50% of those who apply are accepted. Some form of limited in-school experience, often on a voluntary basis, is considered very favorably.
2. During the first summer, students prepare lesson plans for the first six weeks of instruction.
3. The intern program works well only because of close cooperation between the mathematics and secondary education departments in the selection of candidates and supervision of interns.
4. The program has led to cordial relationships between the school districts and the college regarding the hiring of teachers and evaluation of the effectiveness of the intern in the classroom.
5. In this time of rather severe job shortages, we could place more interns if we could supervise them. Interns often have much less trouble finding jobs than do teachers with regular credentials.
6. The summer programs for interns are self-supporting financially.

7. Long-range evaluation and follow-up is subjective, based to some extent on frequent encounters with former interns at professional meetings. The rate of failure is extremely low. Many have become department chairmen, and others have become junior college teachers.

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TEACHING MATHEMATICS TO THE SLOW LEARNER IN THE INNER CITY SCHOOLS

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Very few of our graduating teachers of secondary mathematics have had more than passing attention focused on the task of teaching the slow learner. Furthermore their student teaching experiences tend to involve teaching mathematics to average and above average students in selected suburban communities. On the other hand, secondary schools have been eager to identify prospective teachers who are willing to specialize in this task of providing for the less able student. This is especially true for our city schools with special problems in this area.

The traditional three credit methods course does not provide sufficient time to adequately explore the problem of teaching mathematics to the slow learner. As a result, the Montclair State College mathematics department decided to offer a special course with the title stated above. This course was offered during a three week innovative period that the college scheduled during January, 1972. Twenty students enrolled in the course on a full-time basis for three semester hours of credit under the guidance of two experienced staff members, Dr. Max A. Sobel and Dr. Evan Maletsky. Both instructors have had wide experience in preparing materials for and working with slow learners in mathematics.

The first week of the program consisted of seminars held on campus, during which time such topics as the following were discussed:

Basic characteristics and needs of the slow learner.
Techniques of motivation.
Laboratory and discovery approaches.
Use of audio-visual aids.
Examination of resource materials.

During this first week, each student prepared sample teaching units and materials for possible use in the classroom. These were discussed in groups, and with the instructors concerned. In addition, during this first week, students were sent out in groups of four to various city schools as a means of orientation. Here they met with the appropriate department chairmen who acquainted them with their local problems and indicated the ways in which these college students could be of service to their staff. All of these department chairmen were eager to assist the college in providing opportunities for these students to work with slow learners in their mathematics classes.

During the next week and a half of this innovative course, the college students were sent out to remain on a full-time basis in five different city schools. They were given opportunities to participate in a variety of activities such as observation, tutoring, and serving as teacher aids. In addition, each student had an opportunity to teach at least one or more full periods of classes of slow learners, using the materials and plans that had been developed during the first week of seminars on campus. During this period of time, both staff members visited each of the schools involved, and conferred both with the students and with the local staff as well. Finally, the last three days of the course were devoted to discussion and evaluation of experiences, with further suggestions offered by the instructors in the art of teaching the slow learner.

Each of the two instructors for this course received two semester hours of credit counted towards their spring semester load. This course was one of five innovative courses offered by the department, and involvement by both students and staff was entirely on a voluntary basis. Because of the overwhelming and enthusiastic reception received by this entire innovative period, it is currently being planned for repetition next January with the stipulation that each staff member participate at least once every three years.

Evaluation of this particular course can only be on a subjective basis. However, students, college staff, and local high school staff were all unanimous in their praise of the program. The local schools involved all agreed that our college students were of significant assistance during their period of visitation, and furthermore helped the local staff in a renewal of their interest in searching for ways to meet the needs of the slow learner. The two college staff members were able to offer a course open to volunteers only, and found the student audience to be excited, and receptive to all suggestions. Finally the 20 college students who participated were unanimous in their praise of the program and in their recommendation that a similar program be repeated or implemented as part of the regular college offerings. Perhaps their reactions can best be summarized by the following quotes taken directly from their final evaluation papers:

"It allowed me to remove some fears I had about inner city students. They were not little monsters waiting to drive each teacher up a wall."

"This innovative course was everything any course should be--informative, exciting, and an experience."

"I think this was the greatest experience I had since I've been in college."

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SCHOOL-COLLEGE COOPERATIVE TEACHER EDUCATION PROJECT

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The project has developed a teacher education center within a large network of elementary and secondary schools in northwest suburban Chicago. It is assumed that professional education should be characterized by a substantial clinical component. By "clinical" is meant that element of training which is problem centered and gives training in solving these problems within the context of actual teaching situations. Following directly from the concept of clinical training is the requirement that a college of education have direct, functional and truly cooperative relationships with school systems. That is, colleges of education are to relate to schools as vital parts of a training system, and, concurrently, schools view their work in teacher education as a legitimate commitment rather than a requirement supplementary to their regular instructional responsibilities.

Characteristics and content of the program

a. A broad basis for providing input and delegating responsibility. We are committed to the notion of genuine cooperation with the schools in the design and conduct of professional education preparatory programs. Two main justifications for this are:

i. Competence. Most schools can muster an impressive array of well-qualified people, both in terms of formal training and successful on-the-job performance. This is particularly true if a number of schools can pool their manpower resources.

ii. Credibility. Master teachers in the schools can bring with them, to teacher education, an aura of freshness, stemming from on-the-job experience. They may tend to be attended and referred to with more confidence than are university personnel who, in the eyes of the college students, at least, are far removed from the action and hence, from relevance.

b. Continuity of professional education. No professional is ever fully educated. Yet, teaching historically has been characterized by an enormous chasm between the status of uncertificated and certificated personnel. In the present project,

the teachers in training become involved to a great extent in the ongoing instructional process at the school. Well-defined instructional sequences are assigned to the trainees, to be carried on a sustained basis for up to eight or ten weeks. Full responsibility for preparation, instruction, testing, and grading are handed over to the candidates. And the student teacher is not held responsibility for preparation, instruction, testing, and grading are handed over to the candidates. And the student teacher is not held responsible to an individual teacher or supervisor, but the department and in particular to a teacher education team within that department. Similarly, beginning teachers are not left to shift for themselves, but they, too, may be members of the professional team. These certificated teachers, as they concern themselves with matters of instruction and curriculum, are expected to bring questions and problems as well as suggestions to the teacher education team.

c. A team approach to professional education. Seminars are held on a regular basis in which experienced teachers join forces with teacher educators from the university in deliberating upon the selection of teaching strategies, the examination of the logic of an observed proof or the discussion of the handling of a disruptive classroom incident. In the latter case the expertise of an educational psychologist is also likely to be valuable input. A further characteristic of the team approach to teacher education is that it abandons the apprenticeship view of training. Student teaching must consist of much more than mere imitation of a selected master teacher. There must be analysis, interpretation, and discussion of instructional strategies. There must be trial, ceaseless trial. There must be, perhaps most important of all, some overall structure to the teaching task, a search for general principles which can be applied in day-to-day planning, instruction and evaluation.

d. Variety of educational experiences. A by-product of the apprenticeship model for student teaching, wherein one student teacher is primarily assigned to one supervising teacher, is that the classroom experiences tend to be limited to the subject and grade level assigned to that particular supervising teacher. The present project is designed to provide the student teacher with a broad spectrum of teaching experiences--from elementary school through senior high school (and for some, into junior college) and from low-achieving to advanced classes. An even more desirable feature would be to offer experience in schools located in a variety of cultural and socioeconomic environments.

e. Individualized training. In typical student teaching programs, all trainees are subjected to essentially the same instructional treatment. In the present program, however, deliberate attempts are made to suit the training experience to the interests and needs of the candidates. Some student teachers exhibit a great deal of confidence and insight, and are ready to assume considerable

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responsibility early in the program. Others appear to profit from more supportive classes and to more intensive supervision. The opportunity to choose courses and classes is also important to some student teachers.

f. Team teaching in a small group situation or "mini teaching." An important feature of the first few weeks of the training program is small group instruction called "mini teaching." The essential features of this technique include the assignment of teams of student teachers (say, two or three candidates) to the teaching of small groups of students (say, five or six persons). This team of student teachers is responsible for the sustained instruction of their small group for a period of three or four weeks. The team jointly plans the lessons, teaches the group (and here there is ample opportunity for genuine teamwork as the student teachers assist each other, help to clarify points, do individual tutoring, and so on) and then discusses the teaching. Videotaping of the mini teaching is also done, and serves as a basis for further discussion of the sessions. The regular classroom teacher, the resource teacher for the school, the college teacher and doctoral students in teacher education all are available for observation of classes, leading discussions concerning the teaching, giving demonstration lessons and assisting in future planning.

Potential benefits of the mini teaching are many. The scaled down teaching encounter minimizes many anxieties concerning "going it alone" in a large class. Since the numbers are so small, the student teacher comes to know each student very well, and becomes accustomed to thinking of students as individuals. Furthermore, the tendency to lecture, which is all too common with beginning teachers (a tendency which is natural enough, since imitation of many years of teaching is a powerful instructor) is easier to resist. Finally, the teamwork in presenting a topic, engaging in a discussion concerning questions raised by the students, providing alternative points of view, clarifying issues raised, and so on, appears to be valuable training ground for classes of the future where team teaching is likely to be increasingly common.

The program offers the "package" of techniques of teaching, principles of education, and student teaching, during a sixteen-week semester.

Candidates typically are college seniors in teacher education. Representative numbers involved in the various subject areas are:

Mathematics	12	Science	14
English	15	Social Studies	
Art	10		

Evaluative information available

a. Student teacher and faculty assessment of overall program.
b. Informal evaluative input obtained from personal interviews, and group meetings.

c. Several doctoral dissertations currently underway. One is examining role relationships in this program as compared with the traditional program.

The overall evaluative data are supportive of continued expansion of the program. This will include not only increased numbers, but involvement of students and faculty from other teacher education institutions in the state.

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