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THE CREATION OF A COMPETENCY-BASED INSTRUCTIONAL PROGRAM FOR TEACHERS OF ELEMENTARY MATHEMATICS

by

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TABLE OF CONTENTS

ABSTRACT

This project is the creation of three instructional packages (modules) to develop the needed competencies to teach mathematics in the elementary school. Each module is competency-based, time flexible, individualized, and field-centered. Each module utilizes a variety of learning environments and learning strategies in a manner that puts emphasis on exit competencies rather than attendance and test results.

The modules are developed in three phases with each phase being the basis for one instructional package (module). Phase I deals with the cognitive knowledge needed to teach elementary mathematics. Phase II develops a data analysis of commercial math programs, materials, and resources with regard to mathematical continuums. Phase III will yield competence in the selection, design, planning and implementation of actual classroom lessons.

CHAPTER I

Introduction

Competency-based Teacher Education (CBTE) has been mandated in fourteen states at this time; and there is some type of Competency-based Teacher Education alternative in almost every state. With the advent of Competency-based Teacher Education, a need for a new type of instructional package has developed. Colleges have asked for examples of competency-based materials in all subject areas and found almost nothing developed. Since competency-based instructional materials are in their infancy and almost nothing is available, the wheel is still being invented. Refinement will come through field studies of competency-based instructional materials along with reviews of other infant competency-based programs. But, in order for this to happen, there is a need for competency-based instructional packages that can be field tested.

In a competency-based instructional package there is an overall need for a variety of learning experiences, produced materials, and exposures that are oriented to specific, identified competencies. Step by step a modularized instructional package developes. The first step is the identification of the competencies to be mastered by the student (intern). This identification is made by all role groups involved; those being teachers, college instructors, and students. The identified competencies are general in nature and must be broken down into indicators of competence, usually in the form of behavioral objectives.

The behavioral objectives are written to be measurable and demonstrable in three ways. One is the demonstration of a cognitive knowledge of a given subject matter. An example would be: "can identify a 'greater than' or 'less than' relationship utilizing the correct symbols (<,>)." Demonstration of a performance of a given behavior to display is another way of writing a behavioral indicator. An example of this type would be: "The intern will micro-teach a lesson concerning exponents to a group of four sixth graders." The third way to write behavioral indication is by using product oriented objectives of teaching effectiveness through pupil assessment. An example of this type of objective would be: "Each student will recite the numbers from 0 to 10." Although these objectives are taken out of context, they should give an idea of the types of performance criteria that must be developed to indicate competency development.

With the objective indicators of each competency in mind, "learning activities" must be developed to enable the intern to attain the knowledge, develop the skills and strategies, or produce the material needed to demonstrate each objective or group of objectives. The learning activity is developed either for one objective, a group of objectives that are oriented to one indicator, or a group of indicators that are oriented to one competency.

The learning activity is developed on the following format:

I. The Component (competency to be developed)

II. Module (title of the instructional package)

III. Objectives (only those to be dealt with in this learning activity)

IV. Evaluation Procedure (materials that will show completion with the type of evaluation criteria to be used)

V. Resources (whatever is needed to complete the learning activity)

VI. Activity Direction (a step by step process that must be completed to finish the learning activity).

A group of these learning activities that are to develop the same competency are then grouped together into a competency-based instructional package, generally called a "module." This module is developed on the following format:

I. Course Description

II. Course Goal(s)

III. Course Behavioral Objectives

IV. General Instructions for Course

V. Course Rationale

VI. Course Pre-requisites

VII. Course Evaluation Procedures

VIII. Follow Through

The module "Follow Through" is then followed by the learning activities designated for this instructional package.

These modules are built to be time flexible, field or college centered, and individualized. They are replicable and transportable.

They utilize a variety of learning environments and learning strategies. All in all, they are built with an emphasis on exit requirements in which the learner knows exactly what has to be done to successfully complete each designated competency. All other variables are either spelled out in the module or are negoitable.

Statement of the Project

This project will be the creation of a series of three modules to develop the needed competencies to teach mathematics in the elementary school. The modules will be competency-based, time flexible, individualized and field centered. They will be built on the format stated in the introduction.

Purpose of the Project

With the advent of Competency-based Education, a great need for Competency-based Instructional Materials has come about. In order to meet this need the author will develop a series of modules that will develop the competencies needed to teach mathematics in the elementary school. The major purpose in writing this module will be to create a list of appropriate competencies that will be broken into behavioral indicators. These competencies will be developed in three phases with each phase being the basis for one instructional package (module). Phase I will deal with the cognitive knowledge needed to teach elementary mathematics. Phase II will develop a data analysis of commercial

math programs, material and resources with regard to mathematical continuums. Phase III will yield competence in the selection, design, planning, and implementation of lessons.

The modules will also be built to be responsive to changing needs of interns and revision. This responsive flexibility is made possible by the variety of separate learning activities. Each activity can be changed to meet changing needs and expectancies without a change in the entirety of the module. With this ease in the changing of problem areas, it is possible to have a package (module) that is receptive to criticism and evaluation data. At a later time an ongoing evaluation will be done with all portions of the modules.

General Questions to be Answered

1. Are competencies identified?
2. Are the competencies stated in terms of behavioral objectives?
3. Are course goals stated?
4. Does each instructional package (module) contain a concise course description?
5. Is there a course rationale for each instructional package?
6. Are pre-requisites clearly defined for each instructional package?
7. Are evaluation procedures and exiting requirements clearly identified and complete in each instructional package?
8. Is the time required for completion of each instructional package clearly identified?

9. Are learning activities consistent with the outlined format?

10. Is there a diagnostic pre-test and post-test for each instructional package?

General Procedure

The initial step in the creation of a competency-based package is to determine a philosophy and a conceptual framework to be used as a guide in the designation of competencies. The competencies are then generated from a variety of resources. Some of those resources being teachers, administrators, students, course objectives, knowledge of teaching, needs of schools, task analysis of effective teachers, etc. Given a developed list of competencies to be developed by the intern, these are then broken down in a pattern consistent with the conceptual framework. Each competency is then broken down into behavioral objectives.

The question is then asked, "How will the intern develop and demonstrate the identified competencies and objectives?" With this question in mind, a series of learning activities is developed. These learning activities are also grouped in a consistent fashion with the conceptual framework. The conceptual framework I will use is a four-phased model:

Phase I - Cognitive Development

Phase II - Materials and Resources Available

Phase III - Selection, Design, and Planning of Lessons

Phase IV - Implementation and Evaluation of Lessons

The learning activities are to develop in the intern the needed skills, knowledge, and experience necessary to demonstrate competency. If the assumption was made that a person had no competence, then successful completion of the learning activities should make it possible for the intern to demonstrate minimal competency. Since this assumption is so unrealistic, in that most persons have some degree of competence or cannot acquire the minimal amount of competence, it becomes necessary to develop some flexibility with regard to the diversified needs of the intern(s). The first provision for flexibility is the development of a pre-test to determine what competence the intern already has and what needs must be developed to demonstrate minimal competence. The second provision for flexibility is to allow for a variety of learning experiences so that the intern can find either remediation, if necessary, or another way of developing the competency that is more consistent with his learning style.

The pre-test is developed from the necessary objectives. Theoretically, a problem, demonstration, or observation incorrectly performed would show the lack of competence in a particular objective. This identified objective is related to a particular learning activity or activities. A prescription is then made from the pre-test for the needed learning activities. The intern then pursues the prescribed learning activities so that he may acquire competence.

The student has the option of the learning activities programmed in the module or he may request an alternate learning activity designed by himself. The learning activities can be as varied as imagination and constraints will allow. They will vary from the traditional lecture to self-designed field experiences. How an intern acquires competence should never be the problem; the problem must be the acquisition of competence, for that is our objective.

Also found in the module are the basic component information sections. These will include the Course Description, Course Goal, General Instructions for Course, Course Rationale, Course Prerequisites, Course Evaluations, Course Resources, and Follow Through. The development of these components is the next step in the writing of the modules. Very basically the information guides are developed to answer the following questions for the student:

I. Description:

What is it? What does it look like?

II. Course Goal:

What is the outcome/product of the learning? What will the intern have, or be able to do that is different from when he or she entered?

III. Rationale:

What is the reason for taking the course? Why, from the intern's point of view, is it important?

IV. Course Resources:

What materials (printed, audio, visual) are going

To be needed and used?

V. General Instructions for the Course:

What does the intern have to do to attain the competency identified?

VI. Course Pre-requisites:

What does the intern have to have, or what is it you assume he has in order to start?

VII. Course Evaluation:

How will the intern know when he has attained the competency stated?

VIII. Follow Through:

Where does the intern go from here, or what is the next step?

Since there are no guarantees that a course, module, or learning activity gives the information or develops the appropriate skills, a post-assessment or evaluation must be developed to demonstrate the competencies designated in the module. The assessment or evaluation of desired competencies is developed with primary emphasis on objectives specified earlier. This evaluation completes the competency-based package.

It should also be mentioned that this package is made to be easily changed to better meet the needs of the intern. Renovations are easily made at the instructor's discretion. Whether the changes to be made are in one learning activity or a total renovation of the modular package, the instructor should anticipate the need for changes

in the package and should be open to them because these changes are generally the easiest way for the instructor to improve his instruction.

Limitations

This project has as its objective to create three competency-based instructional packages in the area of mathematics for elementary teachers. The author has chosen to focus on creation only at this time. Field testing and evaluation will occur at a later time.

Summary

The project will create three competency-based instructional packages. The first package, entitled Methods and Materials of Mathematics, Phase I, focuses on cognitive competencies needed to teach elementary mathematics. The second package, entitled Methods and Materials of Mathematics, Phase II, focuses on data analysis of materials and resources available to elementary mathematics teachers. The third package, entitled Methods and Materials of Mathematics, Phase III, focuses on the selection, design, planning, and implementation of mathematics lessons for the elementary classroom. Each package will have a diagnostic pre-test and post-test.

CHAPTER II

Review of the Literature

In the great transition of teacher education the emphasis has changed many times. This review will look briefly at the histroy of teacher education, the traditional program of the past, and some opinions by both professional educators and students. The review will center on two programs now being used and the future implications for the competency-based teacher education. Hopefully, this will lend importance to the need for a continually changing, relevant teacher education program.

In a study done by the Commission on Teacher Education in 1946, a brief history of the twenties and thirties was given. Between 1918 and after the depression of 1929, the increasing enrollment of students gave rise to teaching as a profession. With this increase in the demand for qualified teachers, salaries took an upward trend and provisions were made for tenure and retirement. Along with this demand for qualified teachers came the opportunity to require specific qualifications in order to be certified. The requirements for certification of teachers is what has caused the many programs of teacher preparation. At this time over fourteen states have mandated competency-based certification either as an alternative method or as the only answer.

The amount of college education needed for teacher certification arose steadily along with the four year degree granting colleges. There were one to two year "normal schools," which were aimed primarily

at teacher education. By 1940, only a third of the states were requiring college graduates in elementary education, according to the Commission on Teacher Education. In secondary education, however, all but four states in 1940, required a four year college education. Many attempts were made to deal boldly and intelligently with the matter of teacher education in the twenties and thirties. Three trends in teacher education were prevalent at this time. First was a program aimed at integration and continuity concerning prospective teachers and those in-service. (At this time there was conflict between the graduate of a four year school and the in-service teacher who was forced to attend summer sessions and achieve "credits" rathern than a graduate program.) The second trend was to make sure that teachers' educational experiences would answer the real needs of teachers, the first relevant aim made in teacher education. The third and final trend was toward a concern for general social movements and their basic conflicts in society. It's possible for the educator of today to see that the trends the Commission shows of the twenties and thirties are quite like that of today. One thing should be mentioned here in that teacher education was most entirely academic with almost no emphasis on experience.

As time moved along a pair of somewhat traditional programs of teacher education developed. Conant, in 1963, wrote in his book, The Education of American Teachers, that the self-contained classroom would

continue to be the dominant force in the first three grades during the next ten years. Specialists, he felt, would become more common in grades four through six. This has become a very accurate prediction.

Conant shows two of what he considered traditional programs. By looking at the requirements it is easy to see where the emphasis was being placed and what school of thought each program was aimed at. At this time the two schools of thought in teacher education were: 1) The teacher who was educationally oriented, and 2) The teacher who was subject matter oriented. These are the two programs:

	Riverde College	Lakeside College
General Education	51 Semester hours	56 Semester hours
Academic Major	24	None
Electives	14	16
Educational Psychology, History, Philosophy, and Sociology	12	11 1/3
Methods and Materials of Teaching	6	14
Courses designated as Special Content Courses for Elementary School Teachers	None	18 2/3
Practice Teaching	15	8
Total Semester Hours	122 Semester hours	124 Semester hours

Note the contrast in the two schools. These fictious schools graphically exemplify the two types of schools.

In an analysis of current teacher education programs, it is possible to look at many alternative teacher education programs from traditionally academic to competency/performance-based teacher education. Competency/performance-based teacher education is defined in the October, 1972, issue of Audio Visual Instruction as "a series of learning experiences for pre-service and/or in-service dandidates designed to develop and/or improve the candidates' ability to observably and measurably perform specific tasks directly related to teaching performance." At this point it would be reasonable to study what two experts feel a teacher education program should offer. Arthur W. Combs and Fred J. Wilhelm listed seven basic concepts for teacher education in the Journal of Teacher Education, Fall, 1972. Following are the seven concepts:

1. The production of an effective teacher is a highly personal matter, dependent primarily upon the development of an appropriate system of beliefs.

2. The production of an effective teacher must be regarded as a problem of becoming.

3. The process of becoming must start from security and acceptance.

4. Effective teacher education must concentrate its efforts upon meanings rather than behavior.

5. If sensitivity and empathy are prime characteristics of effective helpers, and if behavior is the product of perception, teacher preparation programs must shift their main concerns from objectivity to subjectivity.

6. The dynamic importance of need in learning must be fully exploited.

7. A final proposition: If the self-concept is as important a determinate of behavior as research suggests, teacher education must actively apply what is known about it.

In a lecture to the American Association of Colleges for Teacher Education, Fred J. Wilhelm, in 1970, expressed definite need for certain types of experiences in teacher education. Wilhelm states seven major criteria concerning experience:

1. Experience should have an exploratory quality, moving around the whole school situation and out into the community.

2. The experience should also have an inward quality at each step helping the young person see himself more clearly as a teacher.

3. If experience is to have this self-revealing quality, the emotional loading at each step must be appropriately light.

4. To achieve appropriate emotional lightness, it is probably best for quite a while to stick to the tasks of getting acquainted and learning to relate easily to children and youth--and colleagues--in relatively informal situations.

5. At least until very late in the sequence, experiences should be selected and evaluated primarily for other than practice or skill building effects.

6. A broad, varied pattern of experiences should bring the student into contact with many and varied potential models.

7. Experience ought to assume an important role as the problem solver.

Combs' and Wilhelm's views of the teacher education process show the continuing dilemma faced by colleges of teacher education. With such diversity among the experts, it is only logical that teacher

education is faltering in its search for relevancy. Experimental programs are abundant in teacher education with almost no agreement from fellow professionals concerning the results. The experienced of the educational profession cling to their pedagogical pulpit and speak of individualized education in open concept schools. They speak of diagnosing the learners' needs as they give their consistent set of lectures that have carried them through previous quarters or semesters. They speak of evaluation of the lesson through an objective oriented planning, and then give trick test questions.

Anyone who has progressed through a teacher education program, according to the author, has seen baffling hypocracy and contradiction. With these perceptions in mind, teacher education begins to sway. Since our major objective in a teacher education program is to produce competent teachers, what more logical evaluation than to test the student teacher's ability to teach. In order to evaluate in this way, experience in the actual teaching process is essential. Literature indicates a movement in teacher education toward the views of Wilhelm and his emphasis on experiencial opportunities.

In a questionnaire study conducted by Zahorik at Wisconsin University in 1971, 350 students were surveyed. Zahorik found the experience the students have in student teaching to be the single most beneficial aspect of the total teacher education program, even though the student felt cramped by his supervising teachers in not experimenting or using

an opportunity to the fullest. Students tended to judge their entire teacher education program by their experiences which are generally only the student teaching experience. The final conclusion of the study was "the total quality and quantity of field-work is insufficient."

Today, in many universities, new teacher education programs are being developed to try and meet the changing needs of education. Following is a description of two of these programs:

The first program, entitled Nebraska University Secondary Teacher Education Program (NUSTEP), was developed by Nebraska University. At Nebraska University, students had viewed the student teaching experience as "meaningful" and "worthwhile." The students were not as pleased with the remainder of the program. In two studies by Moller and Dressel, corcerning practicing first year teachers out of Nebraska, the teachers branded the teacher education program as leaving them inadequate in motivating students, individualizing instruction, and working with students from various sub-cultures. The faculty of Nebraska decided upon a new program. A statement of the type of teacher desired was prepared. They believed the purpose of the teacher education program was to produce sufficient background that could effectively help students develop capabilities and commitments which would lead them to participate effectively, constructively, and on the basis of reason.

In the NUSTEP program, three traditional courses were cast aside. They were: learning in the classroom, special (subject area) methods,

and principles of education. The program was then set up to be performance oriented with two major goals. Those goals were: 1) an experience-centered program where the student would be allowed to practice implementing his theories and skills, and 2) the student should practice ways of individualizing instruction. This change meant changes in staff responsibility. A clinical professorship was established for cooperating teachers; greater use of student teacher supervisors was developed, and an advisory board was created. The program involved and emphasized a variety of micro-teaching experiences with students also serving as teaching assistants in the public schools.

NUSTEP is divided into four phases or spirals. The first spiral is concerned with the teaching concepts. Psychological concepts were used to show the dynamics of the teaching-learning process. In the second spiral, the emphasis moved to application of the concepts acquired. This application was usually accomplished in the student's teacher aid position, first with individuals, and then to the entire class. The third spiral was aimed at individualized instruction competencies. Throughout the spirals, the student is involved in many micro-teaching experiences. These experiences, along with the teacher assistant experiences, afford a number of opportunities to exhibit the minimum competencies described in behavioral objectives the student must be able to demonstrate. In case of a failure by a student, a recycling program goes into operation.

In evaluating NUSTEP, a number of studies have been conducted, all showing favorable results. Two main points were derived from the studies; 1) a much closer relationship was developed among all participants, 2) the teacher assistantships and micro-teaching experiences were considered highly valuable and developed a positive attitude toward teacher education.

In another program outlined in Educational Technology, September, 1972, Burke states that Weber College introduced a unique program called Weber Individualized Learning Kits (WILKITS). This program is an individualized, performance-based teacher education program. The WILKIT program started in September, 1970. Motivation for the program was created from the sterile and unstimulating classes that preceded the WILKITS. The WILKIT program is a series of individualized learning packets with a group of WILKITS making up each course. Each WILKIT is developed with a specific objective or part of the teacher preparation program. The program is two-fold in that both elementary and secondary education training takes place through the WILKITS. Each WILKIT was established on a standard format. The time needed for the completion of a WILKIT was dependent upon importance of the topic and the nature of the experience. The time need ranges from approximately ten to forty clock hours. The format included title, introduction, content, pre-assessment, behavioral objectives, learning experiences, self-evaluation, and proficiency assessment. By looking at the list of WILKITS as they are

divided, much can be learned about the goals of the program:

Professional Course Requirements for
Elementary School Teachers

September, 1971

	Quarter Hours
Education 195, Introductory Field Experience	1
WILKIT:	
W-3 Orientation	
Education 300, Fundamental Skills for Teachers	3
WILKIT:	
W-12 Self-Concept	
Education 324, Basic Skills for Elementary Teachers	4
WILKITS:	
W-57 Tutoring Techniques	
W-26 Reading Study Techniques	
W-35 Handwriting	
W-70 Media Equipment Operation	
W-14 School Health	
W-5 Growth and Development (May be waived upon successful completion of Family Life 150)	
Education 325, Elementary School Curriculum I	6
WILKITS:	
W-27 Reading Readiness	
W-28 Nature and Instructional Implications of Reading	
W-29 Reading Comprehension	
W-30 Basal Approach to Teaching Reading	

Quarter Hours

W-31 Phonic Analysis Skills
W-33 Dictionary Skills
W-36 Spelling
W-38 Oral and Written Communication

Education 326, Elementary School Curriculum II 6

WILKITS:

W-6 Elementary School Mathematics I
W-9 Elementary School Mathematics II
W-42 Inquiry in Elementary Science
W-43 Organizing and Planning for Teaching Elementary Science
W-50 Social Studies in the Elementary Schools
W-54 Elementary Social Studies Instruction
W-40 Music for Children

Education 360, Instructional Skills for Elementary Teachers 4

WILKITS:

W-7 Principles of Reinforcement
W-20 Instructional Resources: Evaluation and Use of Instructional Media
W-60 Media Production
W-22 Purposes and Methods of Evaluation
W-19 Professional Responsibilities
W-37 Listening
W-23 Art (May be waived upon successful completion of Art 250)
W-39 The Language of Music (May be waived upon successful completion of Music 320)

Education 488, Teaching Practicum in Elementary Education 15

	Quarter Hours
WILKITS:	
W-4 Classroom Management	
W-13 Motivation and Learning	
W-21 Classroom Group Meeting	
W-10 Teaching and Learning in the Three Domains	
Education 498, Synthesis of the Elementary Teaching Program	4
WILKITS:	
W-8 Transfer of Learning	
W-16 Backgrounds of Educational Practice	
W-17 Professional Relationships	
W-18 Professional Rights	
Leadership or Service Practicum Prescribed Remediation or Optional WILKITS	
Total Professional	42

Professional Course Requirements for Secondary School Teachers

September, 1971

	Quarter Hours
Education 195, Introductory Field Experience	1
Education 300, Fundamental Skills for Teachers	3
WILKIT;	
W-12 Self-Concept	

Quarter Hours

Education 350, Theoretical Foundations of Secondary Education 4

WILKITS:

- W-57 Tutorial Techniques and Student Records
- W-5 Growth and Development Through Adolescence
- W-7 Principles of Reinforcement
- W-55 Evaluating Teacher Behavior
- W-14 School Health

Education 355, Instructional Skills for Secondary Teachers 6

WILKITS:

- W-1 The Four C's of Teaching
- W-2 Lesson and Unit Planning
- W-80 through 85, Options--Classroom Strategies
- W-22 Purposes and Methods of Classroom Evaluation
- W-20 Instructional Resources: Evaluation and Use of Instructional Media
- W-60 Media Production
- W-70 Media Equipment Operation

Education 495, Teaching Practicum in Secondary Education Student Teaching 15

WILKITS:

- W-10 Teaching and Learning in the Three Domains
- W-4 Classroom Management
- W-13 Motivation and Learning
- W-21 Classroom Group Meetings

Education 499, Synthesis of the Secondary Teaching Program 5

		Quarter Hours
WILKITS;		
W-11	Educational Research and the Teacher	
W-18	Professional Rights	
W-17	Professional Relationships	
W-19	Professional Responsibilities	
W-16	Backgrounds of Education Practice	
W-8	Transfer of Learning	
Leadership Service Practicum Prescribed Remediation or Optional WILKITS		
	Total Professional	34

Constant changes are being made in the WILKITS from a continuing evaluation by faculty, students, and cooperating teachers. Many methods of experience evaluation are being used with the help of the cooperating public schools.

Examining both of these programs, we can see much of what Wilhelm suggested and what students have reflected. The WILKITS reflect many new ideas that must be brought into teacher education programs. In a model in-service teacher education program formulated by Syracuse University, there was a list of ideas for the future. It was: Professional sensitivity training, micro-teaching, simulation, computer-based instruction, objective analysis of instruction largely self-paced, modularized instruction, video-taped feedback of teaching behavior, resident service (intership) and programmed instruction. If a person believes Kahn and Weiner in their book, The Year 2000: A Framework for Speculation and the Next 33 Years, there is a definite need

for a flexible teacher education program. The graduating teachers of 1973 will, in the year 2000, be approximately forty-eight years old and have about twenty-seven years of teaching experience. During this twenty-seven years, Kahn and Weiner suggest some definite possibilities teachers will have to adjust to. Some of these are: "1) varied and reliable drugs to control fatigue, alertness, mood, and perception, 2) practical use of direct electronic communication and computer simulation of the brain, 3) chemical methods for improving memory and learning, 4) pervasive techniques for surveilance, and monitoring and control of individuals and organizations, 5) extensive use of robots and machines 'slaved' to humans, 6) home computers to run the home and communicate with the outside world, 7) powerful new 'education' and propaganda techniques for influencing human behavior." With a belief in these predictions, there will definitely need to be changes, changes that must make a teacher education program relevant to the environment the prospective teacher will be placed in.

The relevancy of a curriculum or a course can only be determined through an analysis by both the students and the developer(s). But, first, there must be something to judge. Competency-based materials are merely one more step in the search for relevancy of teacher education. The package developed for this project is intended to fall into the mainstream of the current teacher education programs.

CHAPTER III

The Modules

Each of the three instructional packages was developed with a specific purpose, a specific rationale, and a specific means of accomplishing the purpose. Throughout the three instructional packages a variety of styles of learning are met with a variety of learning activity alternatives. In order to describe the modules, it is necessary to take each module individually rather than to collectively describe them.

The first module is designed to assist the participant in gaining the minimum amount of cognitive mathematical knowledge needed to teach in the elementary classroom. The module is arranged to offer the participant textbook, laboratory mathematics, Teacher edition, and direct instructional learning activities to acquire the designated competencies.

After a diagnostic test, to ascertain the participant's strengths and weaknesses, a student profile is created which correlates the competency needs of the participant to the module objectives. Utilizing the correlation, a prescription is developed for the competencies that lists the objectives that must be mastered. The participant then moves to the objective chart that keys each objective to a variety of learning activities. Selection of the learning activity deemed most appropriate by the participant is made and completed.

The objectives in Phase I are divided into seven sections. Each of

The seven sections has a final mastery exam. The final text is the determinant of movement through the sections. Movement can be consecutive or at random. Each of the seven sections must be mastered to complete the first phase.

Phase II of the Methods and Materials of Mathematics Component is designed to assist the participant in gaining the minimal amount of knowledge and experience in mathematical materials and resources and the evaluation of those resources with regard to his specific strengths and needs. The course is designed to familiarize the participant with the materials and resources available to him as an instructor in both his particular LEA and through other commercial sources. A variety of learning activities will be available to give the participant experiences in working with various manipulatives, activities, games, visuals and evaluations. A diagnostic test will be used to determine his background strengths in materials and resources. The learning activities will be oriented to a series of objectives that will meet his knowledge deficiencies and will allow the participant to experience a variety of materials and resources.

Also, a section of this module will be oriented to the evaluation of text books. Pupils learn their initial mathematics through the manipulation of concrete objects. Throughout their elementary mathematics program there is a need for relevancy in their mathematics to actual mathematics through applications. In this search for relevancy in the

elementary mathematics curriculum, a variety of materials and resources are necessary in order to meet the needs of students. This course is deisgned to assist the participant in determining which materials and resources are appropriate to demonstrate the applicability of math concepts to a relevant mathematical situation.

Through the utilization of appropriate materials and resources in the classroom, the participant can create an enjoyable mathematical experience rather than learning drudgery through rote memorization, assignment completion and test failures. A mathematics class should be an enjoyable experience as all learning should be. As a teacher, it will be his job to create a classroom atmosphere with that criteria in mind.

Step one of Phase II will once again involve the diagnosis of the learner's needs through a test of the learner's abilities in order to establish his strengths and weaknesses. The diagnosed strengths and weaknesses will then be correlated to the objectives of the module. The diagnostic test has been developed for the objectives of this Phase II Module. It should be easy to see from the correlation, which areas are strength areas and which areas need to be strengthened.

At the conclusion of the diagnostic portion, the learner begins step two, prescription. Prescription entails taking the test results and correlating them to the objectives of the module. From this correlation, the appropriate learning activities are prescribed for the

learner. These learning activities are flexible with respect to time and acceptable alternatives (chosen by the learner and acceptable to the instructor). Hopefully, this module should not take longer than one academic quarter. In the module the learning activities will include the following: listing of the objective of one class for a one year period; writing an inventory of all mathematical materials and resources available to the chosen class; correlating the inventory to the objectives; demonstrations of activities for tangrams, fraction tiles, Number-Blox, abaci, geo-boards, and mirrors; demonstration of games and visuals; designing manipulatives, activities, games, and visuals; designing a textbook evaluation form; and evaluating textbooks.

The third step is implementation which simply involves doing the prescribed learning activities, and having them be acceptable to the instructor. At this point, the responsibility lies squarely on the shoulders of the learner.

Evaluation is the fourth step of the module. In this module, evaluation entails the successful completion of the prescribed learning activities. When all prescribed learning activities are successfully completed, the learner has met his exiting requirements.

Phase III of the Methods and Materials of Mathematics Component is designed to formalize the participant's thought with regard to the integration of the various parts that make up a lesson into a compatible,

realistic and effective whole, the lesson plan and its implementation. In previous modules, the participant has developed knowledge competencies in a cognitive math background, the scope of math programs, the sequence of math programs, and the materials and resources available for mathematical learning activities. This module's emphasis is two-fold. First, it will give the participant an overview of three developmental theories of children. Second, it will assist and evaluate him concerning the actual planning of lessons and their implementation in a micro-teaching situation.

The first portion of the Module will deal with an overview of the developmental theories of Bruner, Gagne, and Piaget. Special emphasis will then be given to the developmental theories of Piaget with respect to Logico-mathematical Development. Combined with the knowledge of Piaget's developmental theory, the student will test and evaluate the development of several students to demonstrate his comprehension.

The second portion of this Module will deal with the pulling together of the parts into the whole of actually planning and teaching. The planning and teaching will be done in a micro-teaching situation. Both planning and teaching will be evaluated by peers and the unit leader. Micro-teaching will involve four steps: 1) Planning, 2) Teaching (Video-Taped), 3) Analysis and Evaluation of Instruction, 4) Re-teach. A follow-up in a tutoring situation will allow the student the opportunity to attempt to implement his newly acquired talents.

Phase III is the final step before entering the classroom with the responsibilities a teacher must accept. This opportunity should be used to diagnose the participant's own weaknesses and needs so that Phase IV, actual teaching, will be no problem. The major reason for learning developmental theories is to empathetically understand the pupils in the classroom. It is imperative that he knows the pupils' strengths and weaknesses. In terms of their development, it is not only unfair but also unreasonable to ask a pupil to do something he is incapable of doing. In terms of the future of appupil, it is traumatic to be forced to live in frustration, and the ramifications of these traumas will be indelibly etched in future performances of the student. Failure is the easiest expectancy to live up to.

Step one of Phase III will involve a diagnosis of the learner's needs with regard to the development of children's Logico-mathematical skills. From this diagnosis, a prescription (step 2) of appropriate learning activities will be developed for each student. All students will be required to do the micro-teaching and tutoring activities.

Implementation of the prescribed learning activities, step three, should be done in numerical order with the exception of Learning Activity #12. Learning Activity #12 will involve a tutoring experience of three to four weeks duration. It will therefore be necessary to begin this activity approximately four weeks prior to the anticipated completion of the module. The preceding eleven learning activities will

involve the student in the following; a general overview of the developmental theories of Bruner, Gagne and Piaget; an indepth experience in the developmental theory of Piaget (with regard to mathematics); a cognitive examination over the developmental theory of Piaget; lesson planning and micro-teaching at four different developmental levels in four different areas of mathematics.

The fourth step is evaluation and will consist primarily of the successful completion of the prescribed learning activities. Completion of all learning activities will entitle the student to a grade of "B", and he will have met all exiting requirements for this phase. For a higher grade, the student will be required to do a project that he and the instructor deem acceptable. A proposal of the project will be developed by the student stating what it is he wishes to do and why it is appropriate to this phase.

CHAPTER IV

Evaluation

To evaluate a created set of modules it is appropriate to answer the questions identified in Chapter I in the section entitled "General Questions to be Answered." Since these questions are also the objectives for the creation of the module, it is significant not only to answer the questions but also to identify where the answers can be found in Chapter III.

Question No. 1: Are Competencies Identified?

Answer: Yes.

In each of the three-phased modules shown in Chapter III, a section designated "III Objectives" lists all of the competencies to be mastered in each respective module. (Refer to Appendix A for examples.)

Question No. 2: Are the Competencies Stated in Terms of Behavioral Objectives?

Answer: Yes.

Each objective stated in all of the three modules is stated as a behavioral objective. These objectives are designated as section "III Objectives" in each module.

Question No. 3: Are Course Goals Stated?

Answer: Yes.

In each module section "II Course Goal" states a general expectancy of what the student can anticipate accomplishing. (Refer to Appendix B for examples.)

Question No. 4: Does Each Instructional Package (Module) Contain a Concise Course Description?

Answer: Yes.

The section designated "II Course Description" in each module gives a succinct description of the purpose for the module and a description of the process the module will take the participant through.

Question No. 5: Is There a Course Rationale for Each Instructional Package?

Answer: Yes.

In each module section "V Course Rationale" explains why the content of each instructional package is needed in order to be an effective elementary mathematics teacher. (Refer to Appendix C for examples.)

Question No. 6: Are Pre-requisites Clearly Defined for Each Instructional Package?

Answer: Yes.

The pre-requisites, if any, are clearly defined in each modules section "VI Course Pre-requisites."

Question No. 7: Are Evaluation Procedures and Exiting Requirements Clearly Identified and Complete in Each Instructional Package?

Answer: Yes.

Exiting requirements and evaluation procedures for each module occur either in section "VII Course Evaluation" or by respective

learning activities.

Question No. 8: Is the Time Required for Completion of Each Instructional Package Clearly Identified?

Answer: No.

In Phase I, too much variation occurs between participants to designate or even approximate a general time expectancy for completion of the module. In Phases II and III, time expectancies are identified in each separate learning activity.

Question No. 9: Are Learning Activities Consistent with the Outlined Format?

Answer: Yes.

Each learning activity follows exactly the format outlined on page 3 of Chapter I.

Question No. 10: Is There a Diagnostic Pre-test and Post-test for Each Instructional Package?

Answer: No.

There is a diagnostic pre-test for each instructional package. The pre-test can be found in the Appendix of Chapter III. Completion of the Learning Activity Requirements substitute for the post-test in the Phase II and Phase III. There is a series of seven post-tests for Phase I. These post-tests are also found in the Appendix of Chapter III.

APPENDIX A

Phase I. Behavioral Objectives

(The interns can do the following:)

1.0 Sets, Numbers, Numerals

1.1 List or describe the members of a set or subset.

1.2 List or describe the union or intersection of two sets.

1.3 Identify finite, infinite sets and universal sets.

1.4 Identify examples of the empty set.

1.5 Name the cardinal number of a set.

1.6 Distinguish between a number and a numeral, and write different names (numerals) for a number.

1.7 Read and write number phrases and number sentences.

1.8 Read and write numerals for numbers to billions, using various kinds of numeration, including exponents.

1.9 Can show numerals in expanded notation, describing face value, place value and total value.

1.10 Can write and interpret exponents.

1.11 Can identify a "greater than" or "less than" relationship utilizing the correct symbols (<,>).

1.12 Can convert from one unit of measure to another in the United States system and the metric system.

1.13 Can rewrite base ten numerals in another base.

2.0 Addition, Subtraction

2.1 Use addition to name the number of objects in the union of two or more disjoint sets.

2.2 Use the terms addend and sum in addition and subtraction.

2.3 Use the commutative property of addition.

2.4 Use the associative property of addition and the identity element.

2.5 Name the sum of zero and any other addend.

2.6 Recall the basic addition facts.

2.7 Understand the meaning of place value in our system of numeration.

2.8 Use subtraction to name the difference in cardinal number between two sets.

2.9 Relate subtraction facts to the corresponding addition facts.

3.0 Multiplication and Division

3.1 Can solve problems involving rates.

3.2 Can round numbers.

3.3 Can estimate and compute products in which factors are less than 1,000.

3.4 Can use the terms factor, quotient, product, dividend, divisor and rate.

3.5 Can do multiplication using standard form and lattice methods.

3.6 Can do division using either standard form or the short form.

3.7 Can interpret a bar graph and determine the ordered pairs for the data shown.

3.8 Can compute the average from given data.

3.9 Can name the mode and median of a set of numbers.

3.10 Can estimate and compute quotients.

3.11 Can compute squares and employ the averaging methods to compute square roots.

3.12 Can discriminate and name the correct multiplication properties; associative, commutative and distributive.

4.0 Geometry

4.1 Identify points, lines, line segments, rays, angles and planes.

4.2 Identify closed curves and simple closed curves.

4.3 Draw such geometric shapes as rectangles, squares, circles, and triangles, and identify their simpler properties.

4.4 Measure line segments.

4.5 Determine if two lines or line segments are parallel or perpendicular.

4.6 Measure angles with a protractor, using the degree as unit.

4.7 Determine the areas and the perimeters of rectangular, square and triangular regions, using formulas or other simple procedures.

4.8 Match two shapes by performing a simple transformation, such as a slide, a turn or a flip.

4.9 Determine whether or not two shapes or angles are congruent.

4.10 Locate in a number plane the point for a given ordered pair, and name the ordered pair for a given point in the plane.

4.11 Describe a plane and some of its properties, particularly with regard to the intersection of a plane by another plane.

4.12 Identify such simple closed surfaces as prisms, pyramids, cylinders, cones and spheres, and identify their simpler properties (faces, edges, and vertices).

4.13 Determine the volumes and the surface areas of some simple closed surfaces.

4.14 Use the Pythagorean theorem to identify a right triangle or to name the measure of one side of a right triangle given the measures of the other two sides.

4.15 Identify congruent or similar shapes, and name the ratio of the matching sides or two similar shapes.

4.16 Discover angles properties of various figures.

4.17 Identify and construct the bisector of an angle or of a line segment.

4.18 Locate a point in a number plane and interpret a bar graph.

4.19 Performa flip and use this idea to identify a symmetrical shape.

5.0 Fractional Numbers

5.1 Can equate fractional numbers to pictorial representations.

5.2 Can name fractional numbers greater than $\underline{1}$ as expanded or mixed numerals.

5.3 Can add and subtract like fractions.

5.4 Can find common denominators.

5.5 Can add and subtract unlike fractions.

5.6 Rename fractional numbers in their simplest form.

5.7 Can do multiplication and division of fractions along with multiplication of fractions and whole numbers.

5.8 Can equate fractions to decimals and percents.

5.9 Can do mathematical problems using decimal system of numeration.

5.10 Can name the ratio formed by comparing two sets of like elements.

5.11 Can name probabilities as fractions.

5.12 Can apply greater than and less than relationships to fractions.

6.0 Number Theory

6.1 Name the factors and multiples of a given number.

6.2 Name the common factors and the greatest common factor of two numbers.

6.3 Name the common multiples and the least common multiple of two numbers.

6.4 Identify prime numbers.

6.5 Draw a factor tree or write a prime factorization for a number.

6.6 Name a number in the binary system of numeration.

6.7 Can add and subtract on the number line.

7.0 Statements

7.1 Read and write number phrases and number sentences.

7.2 Solve number sentences.

7.3 Use a function rule to complete a set of ordered pairs or continue a sequence.

7.4 Use formulas.

7.5 Use ordered pairs of numbers to locate and name points on the number plane.

7.6 Graph functions.

7.7 Can determine if story problems contain needed information and then solve the problem.

7.8 Interpret graphs.

Phase II. Behavioral Objectives

(The interns can do the following:)

1.0 Analysis of Objectives

1.1 List the objectives for a math class, at a particular grade level, for a one-year period.

1.2 Arrange the objective list into a mathematical breakdown oriented to the seven sections of Phase I.

1.3 Utilize the mathematical text adopted in a particular school to list the year's objectives.

2.0 Materials and Resources

2.1 Write an inventory list of all mathematical resources and materials available for a particular classroom or teacher.

2.2 Arrange the inventory list into five categories (manipulatives, games, activities, visuals, and miscellaneous).

2.3 Correlate an inventory of materials and resources to a list of objectives.

3.0 Materials and Resources in Use

3.1 List five uses for tangrams.

3.2 List five uses for fraction tiles.

3.3 List five uses for Number-Blox.

3.4 Given an objective, list a number of manipulative devices, games, activities, and visuals that would be appropriate for the instruction of the given objective.

3.5 Demonstrate place value with an abacus.

3.6 Describe how a mirror can be used in a symmetry demonstration.

3.7 List five uses of geo-boards.

3.8 List three various materials and resources to be used in drill exercises for addition, subtraction, multiplication and division.

3.9 Given an objective, describe a game, commercial or original that can be used to develop the concept of the given objective.

3.10 Given an objective, design an activity for a math group to synthesize the given objective.

3.11 Design a visual to demonstrate a concept or an objective.

3.12 Observe the film, "Donald Duck in Mathmagic Land."

4.0 Textbooks

4.1 Design a textbook evaluation form for mathematics texts.

4.2 List areas of evaluation for textbooks in mathematics.

4.3 Evaluate two mathematics textbook series.

Phase III. Behavioral Objectives

(The interns can do the following:)

1.0 Bruner, Gagne, Piaget

1.1 Name and describe the developmental stages as identified by Piaget.

1.2 Name and describe the eight levels of learning as specified by Robert Gagne.

1.3 Contrast the theories of Piaget, Gagne and Bruner.

1.4 Identify the theorist that appeals to the student.

2.0 Piaget's Developmental Theory of Logical Classifications & Pre-Number Development

2.1 Name and describe the factors that affect the development of a child according to Piaget.

2.2 Define "knowledge" as Piaget would.

2.3 Name the three developmental processes that occur.

2.4 Name Piaget's levels of memory.

2.5 Design an experiment that shows a child's memory level.

2.6 Name the three types of knowledge according to Piaget.

2.7 Determine that the concept of classification must come before the concept of number.

2.8 Define classification by naming three appropriate problems that involve skills in sorting and skills in determining relationships of given groups.

2.9 Test three pupils of varying ages in regard to their development in the area of logical classification.

2.10 Test three pupils of varying ages in regard to their development in the area of seriation.

2.11 Demonstrate a knowledge of conjunctions, disjunctions, implications and negations.

2.12 Define "continuous sets" and "discrete sets."

2.13 With regard to "conservation," identify three children's developmental stages.

2.14 Define ordination and cardination.

3.0 How Children Learn Addition/Subtraction and Multiplication/Division

3.1 Design a readiness test for addition and subtraction.

3.2 Describe the relation of the part to the whole in the addition of numbers.

3.3 Administer an addition and subtraction readiness test to three pupils.

3.4 Describe three appropriate activities for a student who has not reached reversibility of thought.

3.5 Use a matrix to describe the operation of multiplication.

3.6 Design a readiness test to determine if a student has developed to a stage that will allow him to comprehend the operations of multiplication and division.

3.7 Administer a readiness test for multiplication and division to three students.

4.0 Growth of Logical Thought

4.1 Describe the development of a child's consciousness of his own thoughts (introspection).

4.2 Define "transduction" and list two implications.

4.3 Identify examples of inductive and deductive reasoning.

5.0 How Children Learn About Space, Topology and Euclidean Geometry

5.1 Design and administer a test to determine development of spatial relations.

5.2 Chart the development of a child through stages 1, 2, and 3 with regard to spatial relations, topology, Euclidean relationships, and Euclidean concepts.

6.0 Evaluation of Piagetian Development

6.1 Describe an ideal math program for a class of pupils.

6.2 Given a list of Piagetian tast experiments, determine what types of development are being determined and what the implications are.

7.0 The Lesson Plan

7.1 The student will develop a lesson plan with the following criteria:

1. Objective is behaviorally stated in terms of the learner.
2. Resources are clearly identified and appropriate for the learner's level.
3. The teaching strategy is clearly identified (lecture, role play, discovery approach, etc.) and appropriate to objective(s).
4. Procedures are identified and organized.
5. Procedures provide for review, practice, and follow-up.
6. Evaluation is designed for pupil's accomplishment of objectives.

8.0 Micro-Teaching Experiences

8.1 Participate in an experiment designed to illustrate how teaching effectiveness might be improved through micro-teaching and video taping techniques.

8.2 Micro-teach a lesson for the intern team and unit leader with an objective concerning geometry.

8.3 Micro-teach a lesson for the intern team and unit leader with an objective concerning division.

8.4 Micro-teach a lesson for the intern team and unit leader with an objective concerning exponents.

8.5 Micro-teach a lesson for the intern team and unit leader with an objective concerning fractions.

8.6 Be evaluated by the intern team and the unit leader on a video-taped micro-teaching presentation.

8.7 Evaluate self on a video-taped micro-teaching presentation.

8.8 Revise lesson plan and implementation procedures according to designated needs found in lesson evaluations.

8.9 Reteach a lesson after making needed corrections in plan and implementation.

9.0 Tutoring Experiences

9.1 Experience a tutoring relationship.

9.2 Maintain a log of the tutoring relationship including:

a. diagnosed needs
b. perceived needs
c. lesson plans
d. attainments
e. remediation
f. conclusions
g. other

9.3 Describe the accomplishments and possible alternatives that might have been used in the tutoring.

APPENDIX B

Phase I. Course Goal

With the completion of this module, the intern should be able to understand and demonstrate the mathematical competencies expected at the sixth grade level.

Phase II. Course Goal

With the completion of this module, the intern will have acquired a knowledge base and an experience base that will enable him to competently evaluate math textbooks, choose appropriate manipulatives, activities, games and visuals. He will also have the knowledge and experience base to coordinate the objectives of a textbook or continuum to the resources and materials available to him.

Phase III. Course Goal

By completing this module, the student will be able to ascertain the development of pupils, such that lessons planned by the student will be appropriate to the development and needs of the pupils.

The student will also become attuned to his personal teaching style's strengths and weaknesses through several micro-teaching activities.

APPENDIX C

Phase I. Course Rationale

In order to teach mathematics on the elementary level, the teacher must have a basic knowledge of mathematics and be able to do the mathematical operations he or she will be expected to teach.

This module is designed and based on sixth grade math expectancies. Many of the materials the intern will be using are from sixth grade and other elementary classrooms. At the conclusion of this module, he should be able to use the vocabulary in the elementary mathematics texts, understand the mathematical concepts and their relationships, and demonstrate the mathematical operations necessary for the instruction of mathematics on the elementary level.

Phase II. Course Rationale

Mathematics is a component of the elementary curriculum because of its need in the future for the student. If mathematics had no applicability in real life, it would be appropriate to deal with theories and number manipulations solely. But, mathematics is applicable to life's daily routines, so, it is logical to expect a portion of mathematics instruction to deal with the uses of mathematics outside the classroom. The best way to deal with mathematics applicability is through demonstrations involving manipulatives, activities, games and visuals. It is for this reason that Phase II has been designed as it has. Phase II will give the student an experiential background and a knowledge background in manipulatives, activities, games and visuals. At the con-

clusion of this module, the learner should be able to evaluate and select the appropriate materials and resources for any mathematic lesson or math presentation.

Phase III. Course Rationale

As we begin to consider special needs of a student, it is necessary that the teacher also know the probable cause of those needs. In order to create a successful learning atmosphere, the teacher must be able to remove stumbling blocks that hinder the success of students, and develop lessons with expectancies that are both reasonable and possible for the student. The stumbling blocks many students are plagued by are developmental. Without sufficient development the student cannot achieve success in his respective learning activities. Consideration must, therefore, be given for the development of the student. In order to consider development, the teacher must be able to diagnostically determine at what stage of development the student is at. With this determination made, the teacher is then able to prescribe learning activities that will assist the development of the student and those that will be successful for the student.

With the completion of this module, the student should be able to diagnose the child's development and prescribe learning activities that will be both successful and rewarding. Also, the student will be allowed the opportunity to perform all of the essential teaching activities that he will soon be using with students.

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