

A COMPARISON OF THREE INSTRUCTIONAL DELIVERY SYSTEMS  
FOR PROVIDING BASIC MATH SKILLS TRAINING TO  
NON-DEGREE INDUSTRIAL AND TECHNICAL TEACHERS

by

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(ABSTRACT)

The primary purpose of this study was to compare three instructional delivery systems for providing basic math skills training to non-degree industrial and technical teachers. Also examined was the extent to which selected teacher background characteristics were associated with test performance. Additionally, the three treatment groups were compared on the basis of student ratings of selected items on the course evaluation instrument.

Eighty-four non-degree industrial and technical teachers teaching in West Virginia were given a pretest on basic math skills. This pretest was followed by a seven-week period of basic math review and remediation using one of three instructional delivery systems. The three instructional delivery systems included Computer Assisted

Instruction (CAI), Individualized Learning Modules (ILM), and the traditional lecture (LEC). A posttest was administered to participants at the end of the review and remediation period.

An analysis of covariance was used to compare the mean posttest scores for each of the three treatment groups. The pretest score served as the covariate. Results of the study indicated that although there were substantial gains in basic math scores within each treatment group there was no significant difference in mean posttest scores when comparing the three treatment groups.

Computing the Pearson Product-Moment correlation in assessing the relationship between selected teacher background characteristics and posttest scores, it was found that the variables pretest and age were significantly related. Pretest scores had a high positive correlation to posttest scores while age had a moderate negative correlation.

A one-way analysis of variance was used to compare the ratings of selected items on the course evaluation instrument. No significant difference in ratings between treatment groups was found for any of the items compared.

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## CHAPTER I

### The Problem

Improving the academic foundation of teachers and their students has become an issue of great importance to everyone. Many state departments of education, legislatures, and teacher education institutions have responded to pressures for mandated competency testing hoping to improve the quality of education provided and improve the public image of the educational system (Anderson and Wiersteiner, 1987; Watkins, 1985; Danzig, 1983; Rubinstein, McDonough, and Allan, 1982). Various forms of teacher testing have surfaced in three major categories which include basic skills, content specialization, and professional education (Leatherman, 1988).

The basic skills for teacher competency testing most often mentioned in the literature are reading, writing, and mathematics. Some testing programs include additional areas, such as speaking and listening. Many four-year, undergraduate teacher education institutions now make the passing of a basic skills test a condition for admission into and/or exit from the teacher education program (Anderson and Wiersteiner, 1987). Some of the tests currently being used for this purpose include the

Pre-Professional Skills Test (PPST), the National Teacher's Examination (NTE) core battery, the American College Test (ACT), the California Achievement Test (CAT), the California Basic Education Test (CBEST), and the Comprehensive Test of Basic Skills (CTBS).

Some states have contracted with test development specialists in order to tailor tests to specific needs (Leatherman, 1988). For example, West Virginia and Texas contracted with Educational Testing Services (ETS) in developing the PPST for testing prospective teachers' basic skills in their respective states. The state of California also contracted with ETS to have the CBEST developed for its teacher testing program (Watkins, 1985).

Very little can be found in the literature regarding the basic skills of non-degree industrial and technical teachers. However, testing policies for beginning teachers are being developed in most states (Anderson and Wiersteiner, 1987; Duenk, 1989).

#### The Need for Improving the Teachers' Basic Skills

In West Virginia, more industrial and technical teachers are now entering the teaching profession with four-year degrees than in the past; however, the majority of new industrial and technical teachers still do not have a

four-year degree. A review of West Virginia Tech's admission records of new industrial and technical teachers for the 1987-88 school year revealed that 36 of the 45 entering teachers did not have a four-year degree. West Virginia Tech's Department of Vocational-Technical Education serves as the only teacher certification program for industrial and technical teachers in West Virginia. The Report of the State Committee for Redesigning and Refocusing Vocational Education (West Virginia Department of Education, 1987) indicated that in 1987 approximately seventy-five percent of all industrial and technical teachers in West Virginia did not have a four-year degree.

According to a pilot competency testing study conducted by the West Virginia Department of Education (1988a), many entering industrial and technical teachers had been out of high school for over twenty years. Although these teachers met teaching permit requirements, many were in need of remediation in the basic skills in order to effectively incorporate basic skills into their instructional program.

With local, state, and national initiatives focusing attention on basic skills instruction as a part of the vocational instruction program, teacher education programs must be sensitive to the needs of the teacher by providing appropriate preparation for teaching basic skills. Although

industrial and technical teachers may be skillful as practitioners in a trade area, the new occupation of teaching calls for, in most cases, an additional number of basic skills. For example, a welder may be required to master and use more reading and writing skills as a teacher than he was required to use as a welder. This need for teacher competency in basic skills is compounded when the welding teacher is expected to integrate basic skills into the welding curriculum.

Additional factors supporting the importance of teaching basic skills as a part of the overall vocational curriculum include instructional relevance, the changing job market, the increasing high school graduation requirements, the increasing high school dropout rate, and adult illiteracy.

Incorporating basic skills as a part of the vocational curriculum adds important relevance to learning both basic and occupational skills. Basic skills can be applied to realistic job situations that call for their use in performing occupationally specific skills. Mathematical concepts normally taught in an abstract sense can become recognized and appreciated for relevance when applied to concrete situations of an occupational nature (Polto and Rhen, 1988).

The changing job market has attached a greater importance to the acquisition of good basic skills. Naisbitt (1984), in Megatrends, described the shift in our economic base as a change from an industrial society to an information society. The nature of jobs held in industry by current industrial and technical teachers may not have called for the use of basic skills those same jobs now demand. In such cases, there is a probable need for review and remediation in the basic skills as a part of faculty personnel development in improving teaching effectiveness.

Many states have increased high school graduation requirements in an effort to improve the overall quality of education received by the students. These increased requirements have most often come in the form of additional units in math and science. Increased graduation requirements have negatively affected enrollments in many vocational programs making it difficult to maintain previous enrollment levels (Naylor, 1986). Some educational systems have found a partial solution in awarding units of credit in mathematics for math competencies earned as an integral part of a vocational training program (Carlson, 1984). This approach involves an analysis of the vocational curriculum to identify applied math skills that are a part of the occupational skills being taught.

Some educators believe that a lack of basic skills has caused many students to decide to drop out of school. According to Pritz (1988), a focus of attention placed on the teaching and reinforcement of basic skills as a part of the vocational curriculum will help reduce the dropout rate. Pritz cited a high dropout rate, particularly among students with low levels of basic skills achievement, as a major issue behind the challenge to strengthen students' basic skills.

Changing job markets have forced many adults back to school. Many of these adults lack the basic reading, writing, and math skills necessary for learning new occupational skills. To address this problem, it is important that vocational educators receive appropriate training to incorporate basic skills into the instructional program. This training should include necessary review and remediation in the basic skills as well as methods and techniques for teaching basic skills to the student.

#### Providing In-service Training to Teachers

Improving the basic skills of teachers seems to be a very sensitive issue. This appears to be particularly true of non-degree industrial and technical teachers. Methods for improving the teacher's basic skills must be

non-threatening as well as efficient and effective in order to gain the appropriate involvement of teachers.

A major decision involved in the planning of in-service training for improving basic skills of teachers is a determination of the method for delivering instruction. In the past, most personnel development programs employed the traditional lecture as a means for delivering instruction. In recent years, many field-based trade and industrial teacher education programs have adopted or developed material similar to the American Association for Vocational Instructional Materials (AAVIM) performance-based teacher education modules in an effort to add a self-study component to the teacher education program. Advancing technology has introduced computer assisted instruction (CAI), computer managed instruction (CMI), interactive video tape programs, telecommunications, and many other ways of providing instruction on an individual basis or to geographically dispersed clients.

Computer assisted instruction has gained much popularity because of recent reductions in cost of hardware and expanded availability of software. The public school system of West Virginia has received national recognition for its state-wide educational microcomputer network system. Because of the existence of this microcomputer network, CAI



possibilities are immediate and attractive. One potential application of CAI is the review and remediation of non-degree industrial and technical teachers in the area of basic math skills. Many new industrial and technical teachers have been out of the formal school setting for a number of years and need review and, possibly, remediation in order to be more effective with the teaching and reinforcement of basic skills in their instructional program. Applications of CAI for improving basic math skills have proven to be both efficient and effective (Reid, 1986; Glidden and others, 1984; Millar and MacLeod, 1984; Hotard and Cortez, 1983; McConnell, 1983; Meyer and others, 1983).

As previously mentioned, another viable method of delivering instruction is through the use of written material designed for self-study. Linear and branched programmed learning are two formats of individualized learning materials. AAVIM modules designed for performance-based professional teacher education programs utilize a different format that consists of written material and follow-up activities designed to guide students through mastery of teaching competencies. Model answers and self-assessment activities provide individual feedback on a frequent basis. Use of self-study written materials of this

nature may be preferred over CAI by some teachers who lack basic computers skills, are threatened by computers, or do not have convenient access to the use of a computer.

### Statement of the Problem

It was the purpose of this study to compare the effectiveness of three separate instructional delivery systems for providing training to non-degree industrial and technical teachers in the area of basic math skills. The three instructional delivery systems compared were:

(1) computer assisted instruction (CAI), (2) individualized learning modules (ILM), and (3) lecture (LEC).

### Research Questions

Specific research questions addressed in this study were:

1. Which of the three methods is most effective in improving performance on the CAT posttest?
2. For those participants scoring below the state cut-off score on the CAT pretest, which of the three methods is most effective in improving performance on the CAT posttest?
3. To what extent were selected background characteristics associated with test performance?

The teacher background characteristics selected for this study were:

- a. age
  - b. related occupational experience
  - c. teaching experience in current teaching specialization
  - d. other teaching experience
  - e. total semester hours of college credit
  - f. pretest scores
4. Which of the three treatment groups received the highest mean rating on selected items of the "Student Reaction to Instructor and Course" evaluation form? (sample form provided in Appendix C)

Answers to these research questions were intended to serve as a basis for planning teacher training programs for entering and experienced non-degree industrial and technical teachers. This is expected to be especially important to beginning industrial and technical teachers. On September 12, 1988, the West Virginia Department of Education adopted a basic skills competency testing program requiring entering teachers to achieve a specified score on basic skills tests in reading comprehension, language expression, and math.

The decision to focus this study on basic math skills, as opposed to other basic skills areas, was made for three major reasons. First, a pilot competency testing program, sponsored by the West Virginia Department of Education (1988a), indicated a major weakness in this area. In this study, 185 industrial, technical, and health occupations teachers were administered the California Achievement Test, Level 20, in the areas of reading comprehension, language expression, and mathematics concepts and applications. The mean scores for 149 teachers having taught one or more years were: 67.95% (reading comprehension); 68.23% (language expression); and 58.34% (mathematics concepts and applications). Results of the same tests administered to 36 entering teachers (less than one-year of teaching experience) were 72.00% (reading comprehension), 70.78% (language expression), and 56.33% (mathematics concepts and applications). Using the state adopted cut-off score of 58%, 11 of the 36 entering teachers participating in the pilot study would require remediation in math. If the same cut-off score is applied to the 149 experienced teachers participating in the pilot study, 72 teachers would be placed in the category of needing math remediation.

A second reason for selecting math as the basic skill for study was that math seemed to be the area of greatest

concern of industrial and technical teachers regarding the basic skills of their students. By improving the basic math skills of the teacher, it could be expected that the teacher would be better prepared to help students who were deficient in basic math skills.

A third reason for selecting math was that there appeared to be a greater chance for success in that area. Three primary reasons for this belief were: (1) a larger selection of CAI software and other instructional materials were available in math than in other areas making it easier to fit the needs of the targeted population, (2) the nature of math lends itself better to applications of CAI since math skills are based on easily identified steps that are generally sequential in nature, and (3) teachers seemed to be more interested in receiving math instruction as opposed to other basic skills areas.

### Definition of Terms

Key terms and their operational definition for this study include the following:

Basic mathematics skill. A mathematics skill considered to be transferrable across most instructional training programs within the area of industrial and technical education (Greenan, 1983).

Basic mathematics skills test. The California Achievement Test, level 20, sub test "Mathematics Concepts and Application" published by CTB/McGraw - Hill Company of Monterey, California.

Computer Assisted Instruction (CAI). Instruction delivered through the use of computers and computer software. This instruction may include one or more of the following: drill and practice, tutorial, quizzes, and related games. (Darling, 1986).

Effectiveness. The improvement of basic math skills as measured by the "Mathematics Concepts and Applications" section of the California Achievement Test, Level 20, Forms "E" and "F".

Individualized learning modules (ILM). Individualized instruction delivered through the use of "Success in Mathematics" (SIM) modules, part 1 and part 2 series, assigned to participants on the basis of diagnostic test scores.

Industrial and technical education. Any one of several vocational education programs designed to prepare secondary and/or post secondary students for entry-level jobs in industrial and technical areas that fall under Office of Education code number 16 or 17. Office of Education code number 16 identifies technical education programs and Office

of Education code number 17 identifies industrial education programs.

Mastery of the basic math skills. A score of 85% or above on either the pretest or posttest, of the California Achievement Test, level 20, "Mathematics Concepts and Applications".

Lecture (LEC). Instruction delivered through the use of the California Learning Materials math section of levels 16 through 20. This instructional approach consisted of lecture and demonstration performed in the traditional sense.

Pretest. The California Achievement Test, form "E", level 20, sub test "Mathematics Concepts and Application".

Posttest. The California Achievement Test, form "F", level 20, sub test "Mathematics Concepts and Application".

### Importance of the Study

This study was important in that the results may be used to better plan and conduct effective in-service basic math skills review and remediation to non-degree industrial and technical teachers. Efforts by the educational community, both locally and nationally, to improve the academic foundation of students in the public education system have begun to place more emphasis on reading,

writing, and math as an integral part of all instruction. It is believed by many that vocational educators can be particularly effective in improving the basic skills of students because of the opportunity to teach those skills in the applied sense.

With educational systems seeking to improve the quality of education has come teacher competency testing. If industrial and technical teachers are to be effective in infusing basic skills into the teaching of occupational skills, they must possess those skills. Although few states at the time of this study mandated basic skills competency testing of non-degree teachers, there appeared to be an interest by many in developing such a requirement.

Beginning September 12, 1988, West Virginia required all entering non-degree industrial and technical teachers to pass a basic skills test in reading comprehension, language expression, and mathematics concepts and applications. Entering teachers must meet a minimum score of 51 percent on the mathematics concepts and applications test to be issued a vocational teaching permit, which was later to be converted to a five-year vocational teaching certificate. To be eligible for the five-year teaching certificate, a higher minimum score of 58 percent is required. Under those guidelines, an entering teacher might achieve the minimum



score for the issuance of the teaching permit but fail to meet the minimum score for the issuance of a teaching certificate. Those entering teachers failing to meet minimum standards are required to retake the examination for a deficient skill area (reading comprehension, language expression, and/or math) before earning a vocational teaching certificate.

Results of a pilot study by the West Virginia Department of Education (1988a) indicated that a problem might exist in some program areas in recruiting and retaining new teachers from business and industry if basic skills testing was mandated. The study suggested that review and remediation opportunities be provided to help alleviate recruitment and retention problems associated with basic skills testing. This study is important in that it supports this suggestion by comparing viable alternatives for providing effective basic math skills training for those individuals.

## CHAPTER II

### Review of Literature

This study compared the effectiveness of three instructional delivery systems for in-service industrial and technical teachers in the area of basic math skills. The three instructional delivery systems were: (1) computer assisted instruction (CAI), (2) individualized learning modules (ILM), and (3) lecture (LEC). The research literature review focused upon: basic skills and the education reform movement; improving the basic skills of vocational students; identifying basic math competencies; and instructional approaches to teaching basic skills.

#### Basic Skills and the Education Reform Movement

The teaching and/or reinforcement of basic skills as a part of the vocational curriculum has gained much attention in the educational community. Several national and local studies have pointed to a need for renewed efforts to improve the basic skills of all students by revising curriculum, improving teacher preparation, and mandating testing of teachers and students to ensure that minimum competency levels are met. A review of the research literature regarding basic skills and the education reform

movement is divided into two subsections. The first provides a review of major national reports while the second provides a review of reform activities in West Virginia.

### National Education Reform

The National Commission on Excellence in Education (1983), in a report entitled, "A Nation at Risk: An Imperative for Educational Reform", recommended the strengthening of high school graduation requirements by establishing the following minimums: (a) 4 years of English; (b) 3 years of mathematics; (c) 3 years of science; (d) 3 years of social studies; and (e) one-half year of computer science. These revised requirements were referred to as the "new basics". Education reforms addressed in that report were followed by several additional reports addressing the status and quality of the American educational system. Two of the major reports that followed were, "The Unfinished Agenda: The Role of Vocational Education in the High School" (National Commission on Secondary Vocational Education, 1984) and "Tomorrow's Teachers: A Report of the Holmes Group" (Holmes Group, 1986). As with A Nation at Risk, these reports addressed a need for national education reform.

A common thread throughout these reform efforts was a renewed emphasis on the basic skills. "The Unfinished Agenda" indicated that "secondary vocational courses should include instruction and practice in the basic skills of reading, writing, arithmetic, speaking, listening, and problem solving". The Holmes Group established several goals for teacher education including the establishment of standards for entering the profession.

#### Local Reform in Vocational Education

Evidence of reform efforts in vocational education in West Virginia are found in, "Renaissance in Vocational Education" (West Virginia Department of Education, 1986b) and the "Report of the State Committee for Redesigning and Refocusing Vocational Education" (West Virginia Department of Education, 1987). The Renaissance in Vocational Education report was a summary of the results of a two-day conference of local vocational directors and State Department of Education staff held at Canaan Valley State Park, May 15-17, 1986. The purpose of this conference was to set priorities for change in vocational education in West Virginia. Listed among the top priorities for industrial and technical teachers were: (1) a statewide competency testing of teachers in the basic skills and (2) recognition

of academic credit in the areas of math, science, and communications for completion of vocational programs. The redesigning and refocusing effort adopted the above two priorities and focused additional attention on basic skills by recommending revisions in minimum teacher certification requirements, changing teaching degree requirements, and implementing individual teaching improvement plans. Local administrators, surveyed for input in the redesign and refocus study, placed "upgrading the academic foundation of vocational teachers and the upgrading of their knowledge of how to teach the basic skills through their vocational curriculum" as their number one priority regarding needed change. In addition to improving the academic foundation of teachers, high priority was placed on the teaching and/or reinforcement of basic skills in meeting the needs of students.

#### Improving the Basic Skills of Vocational Students

Much of the attention given to basic skills as a part of the vocational curriculum has focused on models and techniques for teaching the basic skills (Liu, 1980; Campbell-Thrane and others, 1983; Hamilton, 1984; Polto and Rhen, 1988; Foster-Haverkamp, 1988; Davis, 1988). This attention stems from a recognized need to improve the basic

skills of students currently enrolled in vocational programs.

### Dropout Prevention

Many vocational educators believe that vocational education can play an important role in reducing the student dropout rate if more emphasis is placed on basic skills as a part of the vocational curriculum. According to Weber (1987), most dropouts demonstrate poor basic skills, poor academic performance, and low scores on intelligence tests. The development of an integrated instructional program that applies academic skills in the context of an occupational area is the basis that must support basic skills instructional efforts in vocational education (Pritz, 1988; Hughes, 1984; Cook, 1985).

Students who are enrolled in vocational programs find themselves behind their academic counterparts in basic skills proficiency levels. Lotto (1983), through a review of previously conducted research studies, found strong support in indicating that academic students were substantially more proficient across basic skills areas than vocational students. Data supporting this was found at the ninth and tenth grade levels, as well as the twelfth grade level at the time of graduation. Lotto also found support

in the research literature for the claim that vocational students' basic skills improve during their vocational training. However, vocational students made smaller gains in basic skills areas than their academic counterpart. Lotto suggests that more research needs to be conducted to determine if students are being afforded the appropriate opportunities to gain basic skills in vocational programs.

### Academic Credit and Vocational Education

Some school systems are now identifying specific basic skills taught as part of the vocational curriculum for granting academic credit in such subject areas as math and science. Carlson (1984) discussed a project sponsored by the Mukilteo School District, Everett, Washington, involving the identification of math and science competencies as a basis for granting cross-credit to high school students enrolled in vocational courses at the Sno-isle Skills Center. Cross credit was described as granting academic credit for academic competencies taught as a part of vocational instruction. For example, electronic students could satisfy academic math requirements toward high school graduation by mastering selected math competency as a part of the vocational electronic curriculum.

Naylor (1986) indicated that as most states increase the number of credits required for high school graduation, progressively less time is being left for vocational education. As of 1985, eleven states had developed a policy of allowing vocational credit to be counted in lieu of science and/or math. Naylor also found that 16 states gave local school districts jurisdiction over such course credit approval. Only three states were identified as having policies prohibiting credit allowance for occupational/technical subjects as a substitute for math or science. It would seem that this leaves the door open, and perhaps even encourages vocational educators to place much more emphasis on the teaching and reinforcing of basic skills as a part of the vocational curriculum in order to combat declining enrollments and improve the quality of the curriculum.

#### Identifying Basic Math Competencies

A major decision involved in an effort to improve the math skills of industrial and technical teachers is that of identifying which math skills are those needed by industrial and technical teachers. In searching the research literature, no list of basic math skills was identified that lay claim to being those specifically needed by an industrial and technical teacher; however, research



literature was identified that attempted to identify what was generally considered to be basic math skills. Although some educators may restrict the definition of basic math skills as computational skills, the National Council of Teachers of Mathematics (1980), in their publication, "An Agenda for Action", recommended that basic math skills be defined to encompass more than computational facility. They indicated concepts and principles should be taught along with computation. A similar list of basic math skills was developed by the Education Commission of the States (1983) and listed in a report entitled, "Action for Excellence: A Comprehensive Plan to Improve Our Nation's Schools". These basic math skills were identified as general to all educational programs and necessary for productive employment.

Greenan (1983) conducted a study designed to determine the basic skills that were generalizable across secondary training programs in 32 vocational training centers in Illinois. Generalizable basic skills were described as being transferrable across secondary vocational programs. A part of these basic skills were 28 math competencies identified as generalizable across industrial and technical programs. These basic math skills were placed in the following seven general categories: (1) whole numbers,

(2) fractions, (3) decimals, (4) percent, (5) mixed operations, (6) measurement and calculation, and (7) estimation.

Pritz (1988) described basic skills by placing them in the two categories of "common-core" basics and "job specific" basics. Pritz's definition of "common-core" basics parallels Greenan's (1983) concept of generalizable basic skills in that this category of basic skills is transferrable across several program areas.

Wentling and Barnard (1984) examined appropriate outcomes for students entering the workforce after high school graduation and for students going on to a community college for advanced training. Comparing the two groups, they found that major skill areas identified were generally the same with the order of priority set for learning as the major difference.

In 1978, the National Council of Supervisors of Mathematics proposed a list of ten basic mathematics skills intended to represent the basic math needs of students not college-bound. This list included computer literacy as a basic math skill. All ten basic math skills were written in rather broad terms; however, when broken down into specific basic math skills, they resembled Greenan's (1983) list of generalizable basic math skills.

### Teacher Competency Testing

Very little research can be found in the literature regarding the assessment and/or improvement of basic skills of non-degree vocational teachers. Likewise, there appear to be no studies identifying the basic skills needed by the industrial and technical teacher in order to be an effective vocational teacher.

Many states have now adopted competency testing policies for teachers who are entering the profession through four-year teacher preparation programs. These competency testing programs are usually administered by local teacher education institutions and, in most cases, include assessment in the three areas of: (1) basic skills, (2) teaching content specialization, and (3) professional education competencies (Leatherman, 1988). The projected future directions of industrial and technical education at the secondary level seem to include competency testing for teachers in the basic skills. Anderson and Wiersteiner, (1987) in conducting a national survey of state vocational directors and chairs of industrial and technical teacher education departments, found that an overwhelming majority of both groups felt that persons entering the teaching profession should be required to pass a standardized basic skills test. Twenty-six percent of the 59 state vocational

directors and state vocational board directors indicated that passing a standardized basic skills test was currently required. Ninety percent of the same group indicated that basic skills testing of entering industrial and technical teachers should be required. Ninety-one percent of both groups anticipated increased competency testing requirements for entering industrial and technical teachers. Likewise, ninety-one percent of the chairs of teacher education departments indicated a current increase in basic skills development as a part of teacher training.

Duenk (1989), in a survey of 53 states and territories designed to identify trade and industrial education certification requirements, reported that in 25 states some type of basic skills testing is mandated. Duenk indicated that a few states meet basic skills testing requirements by requiring non-degree teachers to enroll in an approved university program which includes some form of basic skills testing. Instruments used for testing vary considerably. The California Achievement Test (CAT), which is the instrument used in this research study, is being used in Colorado, Mississippi, Oregon, and West Virginia.

Since 1986, seventeen states have added a requirement of basic skills testing for persons preparing to teach. Some teacher education institutions have reduced the number

of professional education courses required in favor of increased liberal arts requirements. A few institutions have even abolished the undergraduate education degree and require prospective teachers to major in an academic subject (Leatherman, 1988).

### Teacher Competency Testing in West Virginia

The State of West Virginia has adopted a teacher competency testing program referred to as "Policy 5100" (West Virginia Department of Education, 1986a). This policy was designed to assess the competency of persons preparing to enter the teaching profession through a degree granting teacher preparation program. Since most industrial and technical teachers in West Virginia enter teaching without a teaching degree, an alternate teacher competency testing program for non-degree industrial and technical teachers was implemented on September 12, 1988 (West Virginia Department of Education, 1988b). This program was mandated by West Virginia State Board of Education Policy 5106.

The Commonwealth of Kentucky also has an alternate competency testing program for non-degree industrial and technical teachers. Persons entering the teaching profession with a four-year teaching degree, as an Industrial Education, level III teacher, are required to

take the National Teachers Examination. An alternate plan calling for the passing of the Comprehensive Test of Basic Skills (CTBS) as well as a teacher aptitude test is required of non-degree teachers teaching in this category (Kentucky State Department of Education, 1986).

### Background Characteristics and Basic Skills Competency

Little information seems to exist in the research literature regarding the relationship between the personal background characteristics of industrial and technical teachers and basic skills competence; however, some studies have examined the relationship of certain background characteristics and adult achievement as a part of studies designed to compare methods of providing basic math instruction to adults (Reid, 1986; Sewell, 1984; Lyon, 1981)

Reid (1986) found age to be significantly related to achievement in basic math for adults in Adult Basic Education programs examined in a study conducted in Alabama and Louisiana. Sewell (1984) found that the math skills of adult students returning to college were less than that of the traditional-aged students enrolled at the University of Wisconsin-Superior.

Lyon (1981) found age, sex, and previous math skills training to have the greatest influence on mean math scores

for adult college students. Lyon also found that employed students scored significantly better than those not employed.

Fernandez, (1983) in a study of the Florida Teacher Certification Examination (FTCE) program, reported the failure rate for non-degree industrial and technical teachers was 51 percent compared to an overall failure rate of 16 percent. Years of occupational experience was not found to be related to performance on the FTCE.

In a survey of vocational teacher education students at eleven institutions in Ohio, students were asked to identify experiences external to their teacher education program that they considered might prepare them to teach basic skills to their future students. Academic foundation courses were most often mentioned, while employment was also considered to be helpful (Vetter and others, 1983).

No research literature was found that indicated or refuted a significant relationship with basic math skills and background characteristics of industrial and technical teachers although it seems reasonable to expect relationships found in studies involving other adults might also apply to industrial and technical teachers. Age, with a moderately negative correlation, and sex seem to be those variables most often related to basic math test scores.

## Instructional Approaches to Teaching Basic Skills

For this study, three instructional approaches were selected for comparison. The three approaches were computer assisted instruction, individualized instruction through the use of written materials, and the traditional lecture. The following is a literature review of computer assisted instruction and individualized instruction.

### Computer Assisted Instruction

As computer technology advances, more and more applications to education are developed and improved. Computer assisted instruction is one such application that has shown much promise. A review of literature on the applications of CAI for improving the basic skills of students indicates an advancement from simple drill and practice in the 1960's (Suppes and Morningstar, 1969) to the now available CAI software containing sophisticated features such as diagnostic tests, tutorial programs, and report generators. In 1960, research was conducted at the University of Illinois to explore the possibilities for applications of computers in individualized instruction. This research led to the development of a teaching system called PLATO, Programmed Logic for Automated Teaching Operations (Lyman, 1981). PLATO has gone through several



revisions since initial development and has served as CAI software in studies comparing CAI to other instructional approaches (Manuel, 1987; Chambers and Sprecher, 1983; Glidden and others, 1984).

CAI has proven to do as well or better than the traditional classroom method in improving achievement in math skills for different age groups and ability levels. CAI studies have also shown savings in time required for achievement (Chambers and Sprecher, 1983; Hall and Freda, 1982) as well as favorable attitudes toward CAI as a method for learning (Copple, 1981). Several studies comparing CAI with other instructional methods have been conducted using Adult Basic Education (ABE) students and students preparing to take the General Education Diploma (GED) examination who have been out of school for a period of time and are in need of review and remediation in the area of basic math skills (Reid, 1986; Machen Noll, 1986; Robichand, 1986; Glidden and others, 1984; Meyer and others, 1983). Results of these studies have been mixed in regard to significance differences between CAI and other approaches. Similar studies have been conducted using elementary education students, also with mixed results (DelForge and Bloeser, 1977; Millar and MacLeod, 1984; Hotard and Cortez, 1983; McConnell, 1983).

An important contribution made by these comparative studies was the knowledge that supports a claim that traditional approaches compared with CAI are not significantly better. This makes CAI very attractive as an instructional method for providing basic math skills instruction. Robichand (1986), in a review of literature regarding the capabilities of CAI, identified the following attributes of the use of computers and CAI:

1. CAI is interactive causing the learner to be actively involved rather than passively directed.
2. The rate of covering the instructional material is learner controlled. The computer is "infinitely patient".
3. The computer is objective and does not make judgments regarding the student's age, sex, race, or other characteristics.
4. Software, through the use of "branching" techniques, can be written to address individual needs.
5. System allows for privacy in making mistakes and opportunity for repeated practice.
6. Reinforcement and feedback is immediate and systematic.

7. The instructor has more time for other instructional, counseling, and management duties.

### Individualized Instruction

In this study, two individualized approaches to instructional delivery were compared to group instruction. The major difference between the two individualized approaches is that CAI is delivered through the use of computers and computer software, whereas ILM instruction is delivered through the use of written materials. Most of the above listed CAI attributes can also apply to written materials designed to provide individualized instruction.

Individualized written materials have been used successfully in improving the math skills of adults. As with CAI, when compared with the traditional lecture approach, individualized written materials have had mixed results in terms of significantly improving math skills. However, because studies generally show this approach to be equally effective, many of the advantages of utilizing individualized instruction can be realized without sacrificing outcomes (Salser, 1980; Evans and Braby, 1983; Hamel and others, 1982).

Decisions to provide individualized instruction rather than traditional group instruction are sometimes made due to

the lower cost to deliver. Evans and Braby (1983) conducted a study of 37 Navy and Marine Corp courses in which he compared self-paced instruction and conventional instruction finding no significant difference. The self-paced courses were based heavily on written materials. The cost of self-paced instruction was from 36 to 58 percent less than conventional instruction.

A study comparing self-paced instruction with conventional instruction for preparing Navy personnel for operational fleet jobs also found a cost savings in using self-paced instruction. Reduced cost was attributed to a reduction in time required to learn. An interesting finding was that self-paced instruction seemed to benefit higher ability students more than lower ability students (Hall and Freda, 1982).

Hamel and others (1983), in studying different formats for job training materials, found that various learning aids built into individualized materials enticed students into more study time. These techniques included the division of instructional materials into small, easily learned blocks; use of illustrations; distributed practice exercises throughout; self-tests; immediate feedback on participant's responses; and remediation opportunities. These components help to build confidence in learning, which in turn makes

learning more enjoyable and productive (Konvalina, 1980; Morrison and Ross, 1986).

### Summary

The review of related literature can be summarized as follows:

1. A series of national and state education reform reports indicated that state and national education systems have been in an era of reform in recent years. This reform includes a major emphasis on the teaching and learning of basic skills through curriculum revision and competency testing.
2. Education reform in West Virginia has paralleled, to a great extent, that which has and is occurring around the nation.
3. Teaching and/or reinforcing of basic skills as an integral part of vocational instruction has gained much importance in shaping the future direction of vocational education.
4. An improved academic foundation for non-degree industrial and technical teachers is viewed as a personnel development goal of high priority by vocational educators in West Virginia.

5. Little research can be found that identifies those specific basic skills needed by industrial and technical teachers for effectiveness in teaching basic skills in industrial and technical education.
6. Computer assisted instruction shows potential as an instructional method for reviewing and upgrading non-degree industrial and technical teachers in basic math skills. Several successful applications of CAI at the adult level were identified in the research literature.
7. Individualized instruction, through the use of written materials, also shows potential as a viable approach to providing review and remediation in basic math skills to industrial and technical teachers.
8. Competency testing of non-degree industrial and technical teachers will probably take place in most states under an alternative competency testing policy rather than following the same policies developed for degree teachers.

## CHAPTER III

### Research Design and Methodology

#### Overview

This study compared the effectiveness of three separate instructional delivery systems for preparation of in-service, non-degree industrial and technical teachers in the area of basic math skills. The three instructional delivery systems compared were: (1) computer assisted instruction (CAI), (2) individualized learning modules using written material (ILM), and (3) the lecture (LEC). This was a quasi-experimental study utilizing a pretest and posttest design. Selected background characteristics were analyzed to determine their relationship with posttest scores. Course evaluations were completed by participants at the end of the review and remediation portion and compared to determine the students' evaluations of the training received.

#### Basic Design

A survey of all West Virginia industrial and technical teachers to determine their interest in enrolling in a course entitled "Teaching Math in Vocational Education" was conducted in March of 1988. Results of this survey were used to identify site locations for conducting this study.

Each site location was assigned to one of three treatments. Four site locations were assigned the CAI treatment, three site locations the ILM treatment, and three site locations the LEC treatment. Treatments were assigned to site locations based primarily on the expertise and preference of the adjunct faculty person serving a particular location.

The course content consisted of two major components which included: (1) review and remediation and (2) teaching methodology. This study compared three instructional delivery systems used during the review and remediation component.

This was a quasi-experimental study utilizing a pre-test and posttest design. This was a quasi-experimental study as opposed to a true experimental design, because subjects could not be randomly assigned to treatment groups. Random assignment of subjects to treatments could not be achieved because participants resided in such diverse locations.

Pretests and posttests were administered and resulting scores analyzed through the use of analysis of covariance. Pretest scores were used as the covariate. This study also compared, for the three methods, participants' evaluations of instruction received and analyzed selected background characteristics to determine if there was a relationship



between background characteristics and posttest scores. Background characteristics selected for analysis were age, years related occupational experience, years teaching experience in teaching specialization, years of other teaching experience, and total semester hours of college credit.

The review and remediation of basic math skills consisted of seven class sessions of three clock hours each for subjects receiving instruction through the computer assisted instruction (CAI) or the Lecture (LEC) method. Participants receiving instruction through the individualized learning modules (ILM) approach attended sessions only for registration, orientation, testing and for individual tutoring when it was desired. Course activity assignments for the ILM participants were completed through independent study outside the classroom.

The following is a description of the three instructional delivery methods.

#### Computer Assisted Instruction (CAI)

The first session of the CAI group included course registration, administration of the CAT pretest, and course orientation. Course orientation included instruction on the use of computer hardware and CAI software as well as a

general overview of the course. During a seven-week math review and remediation period, participants completed CAI assignments based on the results of CAI generated pretests for each of four test subsections.

Three sections of math review and remediation presented through CAI were conducted in a microcomputer laboratory consisting of IBM (or IBM compatible) microcomputers utilizing Corvus network systems. A fourth CAI section was taught using Apple microcomputers on a Corvus network system. Each lab was capable of accommodating a maximum of twenty students.

CAI software used was the mathematics section of Skills Bank, a basic skills software package published by CTB/McGraw-Hill Company, Monterey, California. This software package was selected over other software packages reviewed for the following reasons:

1. Skills Bank was developed to address the same mathematics objectives that are tested on the California Achievement Test (CAT), level 20.
2. Skills Bank software provided immediate and continual feedback to the student.
3. Skills Bank allowed students to select and complete lessons based on individual need.

4. Mathematical concepts taught and tested in Skills Bank included those identified as generalizable to most industrial and technical areas by Greenan (1983).

Computer labs were not available to participants at times other than that specifically designated for class meetings. During the first hour of the eighth class session the posttest was administered to all participants. Following the posttest, participants completed the "Student Reaction to Instructor and Course" evaluation forms (see Appendix "C"). The remaining portion of the semester addressed teaching methodology and was not considered a part of this study.

#### Individualized Learning Modules (ILM)

The Individualized Learning Modules (ILM) participants were provided individualized instruction utilizing a series of math instructional modules published by Motivation Development Company, Inc., of Bishop, California. These materials are the "Success in Mathematics" Part I and Part II series. This two-part series consists of a total of twenty individualized modules covering basic math skills from working with whole numbers to an introduction to trigonometry. In addition to the twenty modules, the

materials include a diagnostic test, a student examination book consisting of two posttests (parallel forms) for each of the twenty modules, and a teacher's manual and answer key. These materials were selected for use in this study for the following reasons:

1. The diagnostic test provided a method for determining the appropriate entry level for participants.
2. Each module was self-contained.
3. Each module included a pretest with two forms of a posttest available in the student examination book. This provided three opportunities for participants to show mastery of materials in each module.
4. Modules covered a wide range of math concepts allowing for instruction of the objectives measured by the CAT, level 20, pretests and post-tests used in this study.
5. Mathematical concepts taught and tested in Success in Mathematics (SIM) modules included those identified as generalizable to most industrial and technical areas by Greenan (1983).

The individualized learning modules (ILM) participants met only once, as a total class, during the seven-week

review and remediation portion of the course. This session was conducted the first week of the semester and included course registration, course orientation, administration of the CAT pretest, and administration of the SIM diagnostic test. ILM treatment groups were assigned SIM modules on the basis of individual need as determined from the results of the SIM diagnostic test. During the second through the seventh week of the semester, participants completed module assignments through independent study. Participants needing assistance beyond that provided by the modules met with the instructor on an individual basis either after module testing sessions or on an arranged basis.

Module pretests and answer keys are integral parts of each module. Module pretests are self-administered and self-scored. Students scoring below a specified minimum were instructed to complete the activities of that module and then take a posttest. Students scoring at or above the specified minimum on the module pretest were allowed to skip the remaining activities in that module and take the module posttest. Persons failing the posttest, who skipped the module activities, were required to complete the module activities before taking a second posttest. All participants failing the first posttest were encouraged to seek individual assistance from the instructor before taking

the second posttest.

Study time was not controlled for the ILM students. Since these students were without the controls of a classroom setting, less study time may have been spent due to less contact with the instructor and a certain amount of a dependency on the student's self-motivation. It is also possible that some participants may have spent more time on course activities because of the availability and nature of the materials used.

One module posttest session was scheduled per week. Participants attended testing sessions of their choice to take module posttest exams. Students were allowed to take more than one exam in one testing session.

The California Achievement Test (CAT) posttest was administered at the beginning of the eighth week session. The remaining portion of the semester was devoted to teaching methodology and was not considered as part of this study.

#### Lecture (LEC)

The lecture (LEC) method participants were given basic math skills review and remediation utilizing the "California Achievement Test Learning Materials", forms E and F, levels 16 through 20. These materials are designed to deliver

math instruction through the traditional lecture and demonstration approach. These materials are published by CTB/McGraw-Hill Company, Monterey, California. The California Achievement Test (CAT) pretest was administered during the first class session and a posttest was administered at the beginning of the eighth week's class session. Also, as with the other treatment groups, the first class session consisted of course registration, course orientation, and the pretest.

Math competencies covered in class sessions conducted during weeks two through seven were established during the second class session based on group needs as determined from the groups CAT pretest scores. All students identified as part of this study were expected to attend each session. Each class session consisted of a total of three hours.

#### The CAT Pretest and Posttest Instruments

The subtest "Mathematics Concepts and Applications" of the California Achievement Test (CAT), level 20, forms E and F, was selected as the pretest and the posttest for this study. Level 20 denotes that the content of the material being tested is commonly taught in grades ten through twelve. The CAT is published by CTB/McGraw-Hill Company of Monterey, California. The time limit for testing is 50

minutes. Reasons for selecting this test were:

1. It was the test adopted for use by the West Virginia Department of Education for basic skills testing of entering industrial and technical teachers in determining their eligibility for licensure as a teacher.
2. Four forms of the test are available.
3. CAI software (Skills Bank) designed to provide instruction on the objectives being tested on the CAT was available for use in the CAI treatment group.
4. The CAT is easy to administer and can be scored immediately, either by hand scoring or through the use of a test scoring device.
5. Mathematical concepts tested on the CAT test include those identified as generalizable to most industrial and technical areas by Greenan (1983).

The following is a list of important characteristics of the CAT:

1. There were eleven overlapping levels of the CAT, for kindergarten through the twelfth grade.
2. The categories of math objectives tested by



the 55 item "Mathematics Concepts and Application" test along with the number of questions in each category were:

1. numeration (12)
  2. number sentences (6)
  3. number theory (6)
  4. problem solving (20)
  5. measurement (6)
  6. geometry (5)
3. The content categories for the CAT were defined by examining state and district curriculum guides, criterion-referenced assessment instruments, and published tests.

Since this test was developed to test students at the tenth through twelfth grade levels, very little information was available on test validity for testing adults. However, during a previously conducted pilot study by the West Virginia Department of Education (1988a), a panel of twelve industrial, technical, and health occupations teachers systematically analyzed the test in assessing its content validity. Each panel member was asked to rate each question on the CAT, Mathematics Concepts and Applications test, as to the importance that an entering teacher have competency

in the basic math skill being tested by each item. The scale used was 0 to 10 with 10 signifying the highest level of importance. The mean rating for all 55 items was 7.62.

In an attempt to assess the test reliability, a Kuder-Richardson (KR-21) was computed for the posttest. This computation yielded an  $r$  of .97.

CTB/McGraw-Hill (1987) in California Achievement Tests, forms E and F, Technical Report reported alternate test form reliability coefficients for the CAT "Mathematics Concepts and Applications", level 20, from two test administrations within a two and one-half week period of time was  $r=.78$  for grade 11 and  $r=.78$  for grade 12.

CTB/McGraw-Hill also reported that in the construction of the CAT tests, four major steps were taken to reduce ethnic bias. These steps were: (1) careful attention was paid to content validity; (2) test construction strictly adhered to CTB/McGraw-Hill test construction guidelines publication Guidelines for Bias Free Publishing; (3) all materials were reviewed by professionals in the educational community who represented various ethnic groups; and (4) item bias studies were conducted.

## Faculty

Adjunct faculty were employed in accordance with standard operating procedures of the West Virginia Board of Regents. The use of adjunct faculty is common practice within the Department of Vocational-Technical Education at West Virginia Tech. Each adjunct faculty person held state certification for teaching math in the public schools of West Virginia. The role of the adjunct faculty person during the review and remediation portion of "Teaching Math in Vocational Education" course varied depending on which treatment was assigned to his or her group.

Some of the persons enrolled in "Teaching Math in Vocational Education" were not included in the study. To be included in this study, participants had to be a non-degree industrial and technical teacher who had scored less than 85 percent on the pretest. Faculty were instructed to assign persons scoring 85 percent or greater to activities other than math review and remediation. All persons scoring less than 85 percent on the pretest were required to complete math review and remediation activities regardless of educational level or teaching specialization.

Adjunct faculty were provided pre-service orientation in conducting basic math skills review and remediation in accordance to the treatment group they were instructing.

Each faculty person was given individual orientation to their duties and responsibilities through an orientation session in which the researcher visited the adjunct faculty person at the site location where instruction was to occur. This orientation included the following:

### CAI Instructors

1. Orientation to Skills Bank software. As a part of this orientation, CAI faculty were provided sample portions of the software in order to allow them to become familiar with the software prior to beginning instruction.
2. Orientation to use of computer hardware and network software. Each CAI faculty person was provided access to the computer lab and network software to allow for software installation prior to the beginning of the training.
3. Orientation to instructor's role. CAI faculty were instructed to serve only as a lab facilitator to ensure that hardware and software are maintained in good working order and available to participants according to class schedule. Faculty were asked to limit their help to the students to usage of the computer hardware and software.

### ILM Instructors

1. Orientation to "Success in Mathematics" instructional materials and how they were to be used in this study.
2. Orientation to instructor's role. Faculty providing instruction utilizing the ILM approach were instructed to schedule weekly meetings for the purpose of providing individuals with opportunities for testing, individualized counseling, and course activity feedback. No group instruction was to be provided.

### LEC Instructors

1. Orientation to "CAT Learning Materials, Mathematics, Levels 16-20" instructional materials and how they were to be used in this study.
2. Orientation to instructor's role. Faculty providing instruction through the LEC approach were instructed to teach the class as a group utilizing the traditional lecture method of large group instruction.

Full-time faculty within the Department of Vocational-Technical Education at West Virginia Tech conducted

registration and administered the pretests and posttests. Faculty members were given orientation to test administration procedures to ensure all tests were administered in accordance with standard test administering procedures as prescribed by CTB/McGraw-Hill Company. Tests were either hand scored by the faculty person administering the test or scored by a test scoring machine.

### The Interest Survey

In early March of 1988, a survey (see appendix "A") was sent to all industrial and technical teachers to determine their interest in enrolling in a course entitled "Teaching Math in Vocational Education" planned for the Fall 1988 semester. Approximately 208 teachers responded, indicating an interest. Results of this survey are presented in table form in appendix "B". These results were analyzed to determine optimum site locations for conducting the course. Eleven sites were originally selected for participation in this study; however, one site was excluded because difficulties developed in conducting classes according to the planned schedule of the study.

## Subjects

There were 84 subjects who participated in this study. Subjects were enrolled in an off-campus course entitled "Teaching Math in Vocational Education" for the Fall 1988 semester through the Department of Vocational-Technical Education at West Virginia Institute of Technology. All students enrolled in this course were not included as subjects in this study. Only those students meeting the following criteria were included:

1. Participant must be a non-degree industrial and technical vocational teachers teaching on a West Virginia Vocational Permit or five-year Vocational Certificate.
2. Participant must have scored less than 85 percent on the CAT pretest basic math skills test. A score of 85 percent was set to allow for a reasonably high ceiling with which to measure gain scores for participants who scored above the state cut-off score (58%) but still could benefit from review and remediation.

These subjects were employed at state supported vocational training institutions and teaching courses such as carpentry, welding, and auto mechanics to secondary and/or post-secondary students. The certification

guidelines for non-degree industrial and technical teachers were a minimum of six years of progressive industrial, occupational experience in the teaching specialization and a high school diploma or GED.

For the purpose of analyzing data, the subjects of this study were placed into two categories. The first category, referred to as "all subjects", included all 84 participants of the study. The second category of subjects, a sub-population of the first category, consisting of those participants who scored less than 58 percent on the pretest. Fifty-eight percent is the state minimum score required for the issuance of the vocational teaching certificate.

#### Limitations of the Study

1. A major limitation was the lack of availability of basic math skills tests that have been validated for use in the basic skills competency testing of industrial and technical teachers. Many states require degree teachers to pass a basic skills competency test, but very few have established the same requirement for non-degree industrial and technical teachers.
2. The findings of this study cannot be generalized to all industrial and technical teachers in West



Virginia. Individual participants were neither randomly selected for participation nor randomly assigned to treatments.

3. The selection of computer assisted instruction software used in this study was restricted to the capabilities of the computer hardware available for use in the study. Computers available did not have graphics adapter cards installed. Some CAI programs reviewed required the use of a special graphics adapter card. Thus, those programs could not be considered for use in this study.
4. Motivation for the participant to learn was limited mainly to the individual's desire to improve his/her ability in the area of mathematics. Students were only required to participate and were not required to achieve a particular level on the posttest.
5. The subjects of this study were primarily experienced teachers as opposed to beginning teachers. Because of changing technology in industry in recent years, entering teachers may have different background characteristics than those who have been out of industry for several years. Since future math review and remediation

for industrial and technical teachers will focus mainly on beginning teachers failing to meet state established minimum scores, it would have been better to use entering teachers as subjects for the study. However, too few entering teachers were available for participation.

### Delimitation

Several occupations requiring a wide range of math skills were represented in this study. An attempt to control for this was made by addressing only those basic math skills that had been identified as transferrable to most of the occupations in industrial and technical education.

### Hypotheses

The two hypotheses tested in this study were as follows:

- H01. There will be no significant difference in the adjusted posttest mean scores of the three treatment groups.
- H02. For the group of subjects scoring below the state cut-off score on the CAT pretest, there will be no significant difference in the adjusted posttest mean scores of the three treatment groups.

Two additional research questions addressed in this study were:

1. To what extent are selected teacher background characteristics associated with test performance?
2. Which of the three treatments received the highest mean rating on selected items of the "Student Reaction to Instructor and Course" evaluation form?

#### Data Collection

Data collected were selected background characteristics of participants, course evaluation ratings, and CAT pretest and posttest scores. Background characteristics were collected using a specially developed registration form. Background characteristics collected included: previous math courses taken, previous experience in taking courses using the CAI or ILM approach, age, education level, semester hours college credit earned, years industrial experience related to teaching specialization, teaching specialization, and gender.

A course evaluation form entitled "Student Reaction to Instructor and Course" (see Appendix "C") was completed by each participant at the end of the review and remediation

portion of the course. This is the standard evaluation form used by students for evaluating instructors and courses at West Virginia Tech.

### Treatment of the Data

In this study, interested participants were identified through the use of a mail survey. Results of this survey were used to identify site locations with each site location assigned one of three treatments (CAI, ILM, or LEC). Subjects were not randomly assigned to treatments since they were a part of an intact group. Campbell and Stanley (1966) describe such a study as a quasi-experimental, non-equivalent control group design. This design incorporated the use of pretests and posttests in comparing treatment groups. Pretest and posttest scores on the CAT, Mathematics Concepts and Applications, were analyzed and scores compared in terms of percent correct. The treatment of data regarding each hypothesis was as follows:

H01 An analysis of covariance was used to compare the adjusted posttest mean scores for the three treatment groups utilizing pretest scores as the covariate.

H02 An analysis of covariance was used to compare the adjusted posttest mean scores for the population

of subjects scoring below the proposed state cut-off for the three treatment groups utilizing pretest scores as the covariate.

For selected background characteristic variables, a multiple regression analysis was computed to determine if a relationship existed between background characteristics and posttest scores. Background characteristics included were:

- a. age
- b. related occupational experience
- c. teaching experience in current teaching specialization
- d. other teaching experience
- e. total semester hours college credit
- f. pretest score

For selected items on the course evaluation form, a one-way analysis of variance was computed to determine if there was a significant difference in course ratings between the three treatment groups. Items included were item numbers 1, 8, and 17. See Appendix "C" for exact wording of the three evaluation items.

## CHAPTER IV

### Findings

This chapter provides an analysis of the data gathered in this study. The hypotheses of this study were tested statistically to determine their acceptance or rejection. The data are presented as descriptive data, findings associated with hypothesis one, findings associated with hypothesis two, gain scores, background variable relationships, and course ratings by participants.

#### Descriptive Data

Subjects participating in this study were non-degree industrial and technical teachers enrolled in a course entitled "Teaching Math in Vocational Education". A total of 123 teachers were enrolled in course sections at ten different class locations; however, only 84 teachers were industrial and technical teachers without four-year degrees. Those 84 teachers, comprised of seven females and 77 males, served as subjects for this study. Table 1 provides a frequency distribution of teaching specializations for subjects participating in the study.

A description of selected personal background characteristics of participants is presented in Table 2. As

Table 1

Frequency Distribution of Teaching Specializations of  
 Participants (N = 84)

Teaching Specialization	Frequency	Percent
Agricultural Mechanics	1	1.2
Air Conditioning & Ref.	2	2.4
Auto Body	8	9.5
Auto Mechanics	9	10.7
Auto Servicing	1	1.2
Building Construction	3	3.6
Broadcasting	2	2.4
Building Maintenance	7	8.3
Carpentry	3	3.6
Commercial Foods	1	1.2
Computer Programming	1	1.2
Construction Trades	1	1.2
Data Processing	1	1.2
Diesel Mechanics	2	2.4
Drafting	5	6.0
Dry Cleaning	1	1.2
Electricity	3	2.4
Electronics	7	8.3
Graphic Arts	2	2.4
Industrial Electricity	5	6.0
Machine Trades	3	3.6
Masonry	3	3.6
Meat Cutting	1	1.2
Mine Maintenance	2	2.4
Piano Tuning	1	1.2
Power Sewing	1	1.2
Printing	1	1.2
Truck Driving	1	1.2
Welding	6	7.1
Total	84	100.0

Table 2

Descriptive Statistics for Selected Teacher Personal Characteristics (all subjects)

Variable	Minimum	Maximum	Range	Mean	Median	Standard Deviation
Age	28	62	34	46.36	47.00	8.51
Yrs. Related Occupational Exp.	4	48	44	16.87	15.00	9.61
Yrs. Teaching Exp. in Teaching Specialization	.5	24	23.5	9.38	8.50	5.82
Years Other Teaching Experience	0	20	20	.88	0.00	2.87
Total Sem. Hrs. of College Credits	0	128	128	44.19	39.50	24.76



Table 2 indicates, the subjects of this study were rather diverse with regard to personal characteristics of age, years related occupational experience in teaching specialization, and total semester hours of college credit earned. As suggested by the mean of 9.38 for "years of teaching experience in teaching specialization", the subjects of this study were veteran teachers. A count of the number of years teaching experience within the teaching specialization for subjects revealed that 88 percent of the subjects had taught three or more years in their current teaching specialization, while 76 percent had taught five or more years. The median of 0.00 years for "years other teaching experience" existed because so few teachers had taught in another teaching specialization.

In order to analyze data regarding those subjects who scored below the state cut-off score for the issuance of a vocational certificate, some of the findings of this study are reported in reference to those participants scoring less than 58 percent on the pretest. Fifty-eight percent was adopted as the minimum basic math score for the issuance of a vocational teaching certificate.

The mean semester hours of college credit for all participants in this study was 44.19. For participants scoring at or above 58 percent on the pretest, the mean

semester hours of college credit was 49.57. Participants scoring less than 58 percent on the pretest had completed a mean of 39.96 semester hours. For participants scoring at or above 58 percent on the pretest, the mean age was 43.16 years, while participants scoring less than 58 percent on the pretest had a mean age of 48.87 years.

A summary of the subjects' educational level is presented in Table 3. Only seven percent of the subjects possessed a GED, while 93 percent had earned a high school diploma. Only two percent of the subjects had earned an associate degree; however, 95 percent of the participants had completed some college level course work prior to enrolling in this course. The high percentage of subjects with some college, but no degree, can be accounted for, in part, by teacher certification requirements for teacher education courses. In order to earn a vocational teaching certificate, a teacher must complete a twenty-two semester hour certification program. To renew a vocational teaching certificate, valid for five years, six additional semester hours of teacher education course work were required. To be eligible for permanent certification, a teacher must earn a minimum of 32 semester hours of designated college credit.

Data presented in Table 4 indicates that formal math training was received mainly at the high school level with

Table 3  
 Educational Level of Participants by Instructional Approach (all subjects)

Instructional Approach	GED	H.S. Diploma	Vocational School	Some College	Associate Degree
CAI ( $\bar{n}$ =28)	1 (4%)	27 (96%)	5 (18%)	26 (93%)	0 (0%)
ILM ( $\bar{n}$ =26)	1 (4%)	25 (96%)	8 (31%)	26 (100)	0 (0%)
LEC ( $\bar{n}$ =30)	4 (13%)	26 (87%)	9 (30%)	28 (93%)	2 (7%)
Totals ( $\bar{N}$ =84)	6 (7%)	78 (93%)	22 (26%)	80 (95%)	2 (2%)

NOTE: Numbers displayed for each educational level represent the number of participants attaining the educational level within each instructional approach group. Some participant are represented in more than one category (educational level).

Table 4

## Math Level of Participants by Instructional Approach (all subjects)

Inst. Appr.	High School Level				College Level				
	Basic Math	Algeb.	Geo.	Trig.	Basic Math	Finite	Algeb.	Geo.	Trig.
CAI n=28	26 (93%)	14 (54%)	10 (36%)	2 (7%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
ILM n=26	19 (73%)	15 (58%)	11 (43%)	4 (15%)	5 (19%)	1 (4%)	1 (4%)	1 (4%)	1 (4%)
LEC n=30	28 (93%)	16 (53%)	7 (23%)	9 (30%)	10 (33%)	1 (3%)	1 (3%)	0 (0%)	0 (0%)
Total N=84	73 (87%)	45 (54%)	28 (33%)	6 (7%)	16 (19%)	2 (2%)	2 (2%)	1 (1%)	1 (1%)

NOTE: Numbers displayed for each math level represent the number of participants completing a math course within each category for each instructional approach group. Some participants are represented in more than one category (math level).

54 percent of the subjects having had at least one algebra course in high school. Nineteen percent of the participants had completed a basic math course at the college level. Only two persons in the study had completed a college level math course beyond the basic math level.

Table 5 provides a listing of the pretest means, posttest means, and standard deviations for each of the ten class sections along with the number of subjects who participated at each section location. There were four class sections for the CAI group, three class sections for the ILM group, and three class sections for the LEC group. The data in Table 5 is representative of the total 84 participants of this study.

Table 6 presents data similar to that presented in Table 5 for a subpopulation of 47 participants. This subpopulation was defined as those subjects who scored less than 58 percent on the pretest. Presented are pretest means, posttest means, and standard deviations by class location for those subjects addressed by hypothesis 2.

A summary of the pretest means, posttest means, and their respective standard deviations by instructional insert approach is presented in Table 7. This data represents all 84 subjects and is broken into the three instructional approach groups. Pretest means, posttest means, and

Table 5

## Means and Standard Deviations by Class Locations (all subjects)

Instruct. Approach	Class Loc. Code	n	Pretest Scores		Posttest Scores	
			Mean	Standard Deviation	Mean	Standard Deviation
CAI	1	7	54.86	13.07	62.14	11.36
	2	8	51.24	11.49	53.38	11.07
	3	9	59.14	8.68	60.67	6.22
	4	4	54.95	28.08	61.00	19.61
ILM	5	9	60.89	12.83	63.67	13.41
	6	14	55.66	14.95	61.86	14.41
	7	3	65.33	20.23	71.33	13.32
LEC	8	11	49.56	13.53	55.36	14.40
	9	12	47.58	16.91	55.83	17.52
	10	7	56.29	12.34	63.00	18.30

Table 6

Means and Standard Deviations by Class Locations (for subj. scoring &lt; 58% on pretest)

Instruct. Approach	Class Loc. Code	n	Pretest Scores		Posttest Scores	
			Mean	Standard Deviation	Mean	Standard Deviation
CAI	1	4	47.00	8.29	58.25	5.91
	2	6	46.82	9.10	49.67	9.42
	3	2	44.50	1.27	52.50	4.95
	4	2	35.40	27.01	47.50	17.68
ILM	5	4	50.75	7.23	55.00	16.15
	6	9	46.40	6.38	56.56	12.90
	7	1	42.00	00.00	56.00	00.00
LEC	8	7	40.76	6.37	50.29	11.24
	9	7	35.29	9.98	46.57	15.98
	10	5	49.60	5.73	54.40	11.93

Table 7

Means and Standard Deviations by Instructional Approach (all subjects)

Instructional Approach	Pretest Scores		Posttest Scores	
	Mean	Standard Deviation	Mean	Standard Deviation
CAI (n=28)	55.21	13.85	59.00	11.32
ILM (n=26)	58.59	14.62	63.58	13.73
LEC (n=30)	50.34	14.66	57.33	16.35
Tot. Subj. (N=84)	54.52	14.62	59.82	14.10



standard deviations for the total subjects are also displayed.

Table 8 displays pretest and posttest data on the sub-population of 47 subjects who scored less than 58 percent on the pretest. The pretest means, posttest means, and standard deviations for the total subjects ( $N=47$ ) are also displayed.

### Findings Associated With Hypothesis 1

A one-way analysis of covariance, utilizing pretest scores as the covariate, was used to compare the posttest mean scores for the three treatment groups. The dependent variable was the posttest score. The analysis of covariance was used to adjust the posttest means on the basis of the covariate (pretest scores) and compare the adjusted posttest means to determine if they were significantly different from one another.

To determine if the assumptions for an analysis of covariance were met, two tests were conducted. The Bartlett-Box test for homogeneity of variance was conducted to determine if the variance in pretest scores were significantly different between the three treatment groups at the beginning of the treatment period since subjects could not be randomly assigned to each treatment group.

Table 8

Means and Standard Deviations by Instructional Approach (for subjects scoring < 58% on the pretest)

Instructional Approach	Pretest Scores		Posttest Scores	
	Mean	Standard Deviation	Mean	Standard Deviation
CAI (n=14)	44.91	11.00	52.21	9.26
ILM (n=14)	47.33	6.59	56.07	12.77
LEC (n=19)	41.07	9.34	50.00	12.99
Tot. Subj. (N=47)	44.08	9.37	52.47	11.95

Results of this test was an F of .054 (P =.948). Therefore, the null hypothesis was not rejected. To determine if the assumption of linearity was met, a scatter plot was run. This scatter plot of pretest and posttest scores revealed a linear relationship between the covariate and dependent variable.

Results of the analysis of covariance are presented in Table 9. No significant difference between the posttest means of the three groups was found. Therefore, this study failed to reject hypothesis 1.

#### Findings Associated With Hypothesis 2

A one-way analysis of covariance, utilizing pretest scores as the covariate, was used to compare the posttest mean scores for the three treatment groups. The three groups compared were sub-populations of the three treatment groups tested under hypothesis 1. The subjects used to test hypothesis 2 were defined as those subjects who scored less than 58 percent on the pretest. The dependent variable was the posttest score. The analysis of covariance was used to adjust the posttest means on the basis of the covariate (pretest score) and compare the posttest means to determine if they were significantly different from one another.

Table 9

Analysis of Covariance Comparing Adjusted Posttest Mean Scores for the Three Treatment Groups (all subjects, N=84)

Source	Sums of Squares	df	Mean Square	F	Sign. of F
Covariate (pretest)	10481.916	1	10481.916	141.247	.000
Main Effects	77.617	2	38.809	.523	.595
Explained	10559.553	3	3519.844	47.431	.000
Residual	5936.788	80	74.210		
Total	16496.321	83	193.751		

To determine if the assumptions for an analysis of covariance were met, two tests were conducted. The Bartlett-Box test for homogeneity of variance was conducted to determine if the variance in pretest scores were significantly different between the three treatment groups at the beginning of the treatment period since subjects could not be randomly assigned to each treatment group. Results of this test was an F of 1.593 (P =.204). Therefore, the null hypothesis was not rejected. To determine if the assumption of linearity was met, a scatter plot was run. This scatter plot of pretest and posttest scores revealed a linear relationship between the covariate and dependent variable.

Results of the analysis of covariance are presented in Table 10. No significant difference between the posttest means of the three groups was found. Therefore, this study failed to reject hypothesis 2.

#### Gain Scores

A comparison of pretest with posttest mean scores, along with the mean percent gain above pretest scores, is presented in Table 11. The highest percent mean gain was by participants who scored less than 58 percent on the pretest.

In examining the gain from pretest scores to posttest

Table 10

Analysis of Covariance Comparing Adjusted Posttest Mean Scores for the Three Treatment Groups (for subjects scoring < 58% on the pretest,  $N=47$ )

Source	Sums of Squares	df	Mean Square	F	Sign. of F
Covariate (pretest)	3277.685	1	3277.658	43.069	.000
Main Effects	21.529	2	10.764	.141	.869
Explained	3299.187	3	1099.729	14.450	.000
Residual	3272.515	43	76.105		
Total	6571.702	46	142.863		

Table 11

Pretest to Posttest Mean Gain Score Comparisons

Participants	Pretest Mean Score	Posttest Mean Score	Mean Gain Score	Std. Dev. (Gain Scores)	Percent Gain (Mean Gain) Pretest
Participants Scoring < 58% on Pretest (n=47)	44.08	52.47	8.39	8.51	19.03
Participants Scoring => 58% on Pretest (n=37)	67.78	69.16	1.38	8.52	2.04
All Participants (N=84)	54.52	59.82	5.30	9.16	9.72

scores for all subjects ( $N = 84$ ), it was determined that a mean gain of 3.39 points on the posttest represented a 6.14 percent gain over pretest scores for the CAI group.

Similarly, a mean gain of 4.99 points represented a mean gain of 8.52 percent for the ILM group, while a mean gain of 6.99 represented a mean gain of 13.86 percent for the LEC group. The mean gain from pretest scores to posttest scores for all subjects was 5.30 points. This represented a mean percentage gain of 9.72 over pretest scores.

In examining the gain from pretest scores to posttest scores for subjects scoring less than 58 percent on the pretest, it was determined that a mean gain of 7.30 points on the posttest represented a 16.25 percent gain over pretest scores for the CAI group. Similarly, a mean gain of 8.74 points represented a mean gain of 18.47 percent for the ILM group, while a mean gain of 8.93 points represented a mean gain of 21.74 percent for the LEC group. The mean gain from pretest scores to posttest scores for all subjects scoring less than 58 percent on the pretest was 8.39 points. This represented a mean percentage gain of 19.03 over pretest scores.



### Background Variable Relationships

Table 12 displays the Pearson Product-Moment correlations among selected variables of the study. The highest correlation coefficient with the criterion variable (posttest scores) was obtained by the correlation with the pretest variable. This correlation produced an  $r$  value of .797. The second highest level of relationship,  $r = -.540$ , was between age and posttest scores. Table 13 presents the results of a regression of selected independent variables on posttest scores that was run to determine the individual and collective contribution(s) to the posttest scores by each of six selected variables. Only the pretest scores and age contributed to posttest scores at a significant level ( $p < .05$ ). This analysis yielded a multiple R of .818 and a multiple R square of .669 when all six variables were considered.

Table 14 displays the Pearson Product-Moment correlations among selected variables of the study for participants scoring less than 58 percent on the pretest. The highest correlation coefficient with the criterion variable (posttest scores) was obtained by the correlation with the pretest variable. This correlation produced an  $r$  value of .706. The second highest level of relationship,  $r = -.465$ , was between age and posttest scores. Table 15

Table 12

Correlation Matrix for Independent Variables (all subjects, N=84)

Variables	1	2	3	4	5	6	7
1. Age	1.000	.594	.277	.187	.062	-.497	-.540
2. Rel. Occup. Exp.		1.000	.036	.287	.061	-.257	-.271
3. Teach. Exp. in Spec.			1.000	-.092	.287	-.197	-.155
4. Other Teaching Exp.				1.000	.108	.001	.001
5. Total Sem. Hrs. Cr.					1.000	.162	.083
6. Pretest Score						1.000	.797
7. Posttest Score							1.000

Table 13  
 Regression of Independent Variables on Posttest Scores (all subjects, N=84)

Variable	B	SE B	Beta	T	Sig T
Age	-.38946	.15655	-.23510	-2.488	.0150*
Rel. Occup. Exp.	.05621	.12391	.03833	.454	.6514
Teach. Exp. in Spec.	.15899	.17863	.06567	.890	.3762
Other Teaching Exp.	.21578	.34263	.04390	.630	.5307
Total Sem. Hrs. Cr.	-.02443	.04066	-.04290	-.601	.5498
Pretest Scores	.68541	.07551	.71061	9.077	.0000*

Table 14  
 Correlation Matrix of Independent Variables (for subjects scoring < 58% on the  
 pretest, N=47)

Variables	1	2	3	4	5	6	7
1. Age	1.000	.634	.208	.200	-.132	-.409	-.465
2. Rel. Occup. Exp.		1.000	.093	.247	.054	-.275	-.254
3. Teach. Exp. in Spec.			1.000	-.046	.413	-.292	-.200
4. Other Teaching Exp.				1.000	.101	-.201	-.204
5. Total Sem. Hrs. Cr.					1.000	.121	.172
6. Pretest Score						1.000	.706
7. Posttest Score							1.000

Table 15

Regression of Independent Variables on Posttest Scores (for subjects scoring < 58% on the pretest, N=47)

Variable	B	SE B	Beta	T	Sig T
Age	-.35300	.22198	-.24195	-1.590	.1197
Rel. Occup. Exp.	.08584	.15923	.07694	.539	.5928
Teach. Exp. in Spec.	-.03111	.28120	-.01469	-.111	.9125
Other Teaching Exp.	-.34218	.62971	.06210	-.543	.5899
Total Sem. Hrs. Cr.	.04110	.07093	.07516	.580	.5656
Pretest Scores	.76877	.16011	.60257	4.800	.0000*

presents the results of a regression of selected independent variables on posttest scores that was run to determine the individual and collective contribution(s) to the posttest scores by each of six selected variables. Only the pretest scores contributed to posttest scores at a significant level ( $P < .05$ ). This analysis yielded a multiple R of .739 and a multiple R square of .547 when all six variables were considered.

#### Course Ratings by Participants

Mean rating scores between the three treatment groups for selected items on the course evaluation form were compared using a one-way analysis of variance procedure. The ratings for items 1, 8, and 17 of the "Student Reaction to Instructor and Course" were collected at the end of the treatment period. This form is the standard course and instructor evaluation instrument used by West Virginia Tech in evaluating all courses taught by the college. Because of the confidentiality of the evaluation process, the ratings of the 84 subjects of this study could not be separated from the ratings of persons who participated in the course, but were not a part of this research study. Therefore, results presented in Table 16 represent the evaluation instrument item ratings for all those participating in the course who

Table 16

Analysis of Variance of Ratings for Selected Course Evaluation Items by the Three Treatment Groups

Item No.	Sum of Squares	df	Mean Squares	F Ratio	F Probability
Item No. 1					
Between Ss	.659	2	.329	.747	.477
Within Ss	46.305	105	.441		
Item No. 8					
Between Subjects	.195	2	.087	.147	.864
Within Subjects	69.546	105	.662		
Item No. 17					
Between Subjects	.690	2	.345	1.134	.326
Within Subjects	31.940	105	.304		

completed the "Student Reaction to Instructor and Course" form (N=106). Item rating responses were coded on a "0" to "5" scale with "5" signifying the highest rating. One-hundred and eight persons completed course evaluation forms. This represented 87.8 percent of all persons enrolled in the course.

Item number one of the "Student Reaction to Instructor and Course" evaluation instrument asked the participant to rate the math review and remediation portion of the course by responding to the question, "Is course material presented in an interesting manner?". Participants of CAI responded with a mean rating of 4.61, ILM participants responded with a mean rating of 4.42, and LEC participants responded with a mean rating of 4.50.

Item number eight of the evaluation instrument asked, "How much are you learning from this course?". The CAI participants gave a mean rating of 4.29, the ILM participants a mean of 4.23, and the LEC participants a mean of 4.19.

Item number 17 of the evaluation instrument asked, "Considering everything, how do you rate the instruction in this course?". The CAI participants gave a mean rating of 4.63, the ILM participants gave a mean rating of 4.55, and the LEC participants gave a mean rating of 4.75.



A one-way analysis of variance was used to compare the treatment group mean ratings for each of the three evaluation items. Results of this are presented in Table 16. Results of the analysis of variance did not show a significant difference in mean rating scores between the three treatment groups on any of the three evaluation items.

## CHAPTER V

### Summary, Discussion, and Recommendations

#### Summary

##### The Problem

With an emphasis on the teaching and learning of basic skills has come the competency testing of teachers in the basic skills. In West Virginia, a special teacher competency testing program requires that entering industrial and technical teachers be tested in the areas of reading comprehension, language expression, and mathematics. A pilot study, conducted by the West Virginia Department of Education (1988a) in which 185 industrial and technical teachers were tested, revealed a weakness in mathematics for both the entering and the experienced teacher. Results of that pilot study indicated a need to provide math instruction to teachers in an effort to make them more effective in teaching basic math skills as a part of their instructional program.

This study compared three instructional delivery systems in providing basic math skills training to non-degree industrial and technical teachers. The three systems compared were Computer Assisted Instruction (CAI), Individualized Learning Modules (ILM), and Lecture (LEC).

The two hypotheses tested in this study were:

H01. There will be no significant difference in the adjusted posttest mean scores of the three treatment groups.

H02. For the group of subjects scoring below the state cut-off score on the California Achievement Test (CAT) pretest, there will be no significant difference in the adjusted posttest mean scores of the three treatment groups.

Two additional research questions addressed in this study were:

1. To what extent are selected teacher background characteristics associated with test performance?
2. Which of the three treatment groups received the highest mean rating on selected items of the "Student Reaction to Instructor and Course" evaluation form?

### Procedure

Eighty-four non-degree industrial and technical education teachers, participating in a course entitled "Teaching Math in Vocational Education", were given a pretest on basic math skills. This pretest was followed by a seven-week period of

math review and remediation using one of three instructional delivery systems. Upon completion of the seven-week math review and remediation period, a math posttest was given.

Math pretests and posttests administered were level 20, forms "E" and "F" of the California Achievement Test (CAT). Instructional material used in the CAI treatment group was the Skills Bank computer assisted software package published by CTB/McGraw-Hill Company. Instructional material used by the ILM treatment group was the "Success in Mathematics", Part I and Part II series published by Motivation Development Company, Inc. The LEC group was given instruction utilizing the "California Achievement Test Learning Materials" also published by CTB/McGraw-Hill Company.

Ten course sections were taught at ten different locations throughout the state of West Virginia during the fall semester of 1988. Four sections received instruction through CAI, three sections through ILM, and three sections through the LEC method. Total number of subjects participating in each of the three treatment groups were 28 (CAI), 26 (ILM), and 30 (LEC).

### Methodology

This was a quasi-experimental study utilizing a pre-test and post-test design. In addition to comparing posttest means, this study examined relationships between selected

background characteristics and posttest scores and assessed differences in participants' evaluation of the three delivery systems.

Subjects were administered a math pretest before receiving basic math review and remediation. CAI and LEC classes met for three hours, once a week, for seven class meetings, while the ILM participants met only for orientation, testing, and as needed on an individual basis. At the beginning of the session conducted during the eighth week of the semester, a posttest was administered to all participants. Also, during the eighth week of the semester, a course evaluation was completed.

### Major Findings

Subjects of the study, comprised of seven females and 77 males, had an average age of 46.36 years, an average of 16.87 years of related work experience and had taught an average of 9.38 years in their current teaching specialization. Ninety-eight percent of the subjects had less than an associate degree. The educational background of the subjects included a mean of 44.19 semester hours of college credit. College credit previously earned by participants consisted chiefly of teacher education course work required to maintain their teaching certification. For example, the average participant,

having taught in their teaching specialization for 9.38 years, would have to have completed a minimum of 26 semester hours to earn and maintain their teaching certification. Most teachers had exceeded the minimum because of an incentive to earn a higher salary level by earning additional semester hours of course credit. Courses used to satisfy additional salary increment requirements were predominately teacher education courses and teaching content specialization courses rather than math courses. Eighty-one percent of the participants had never had a math course at the college level.

An analysis of covariance was used to compare the posttest mean scores using the pretest scores as the covariate. This statistical procedure was used for testing each of the two hypotheses. In comparing adjusted posttest mean scores for all subjects it was found that there was no significant difference between the three groups. Likewise, when comparing the posttest mean scores for those subjects scoring less than 58 percent on the pretest (the state established cut-off score), no significant difference was found.

The percent of mean gain is important in understanding gains made by the participants over their pretest score. Although in some instances posttest scores did not meet state standards for teacher certification, considerable improvement in scores was realized when taking into account the low

pretest score. The mean percent gain from pretest to posttest scores (percentage points gain divided by the pretest score) for each instructional approach was substantial, ranging from a low of 6.14 percent to a high of 21.74 percent. The mean percent gain for all participants was 9.72 percent, while the mean percent gain for those participants scoring less than 58 percent on the pretest was 18.94 percent.

In assessing the relationship between selected background characteristics and posttest scores, it was found that only pretest score and age were significantly related to the posttest score. There was a high positive correlation ( $r = .797$ ) between pretest scores and posttest scores and a moderate negative correlation ( $r = -.540$ ) between age and posttest scores for participants of this study ( $N = 84$ ).

A one-way analysis of variance revealed no significant difference between the three instructional approach ratings by participants on the three items of the "Student Reaction to Instructor and Course" evaluation.

### Discussion

The findings of this study is focused on only the population of this study and should not be generalized to all industrial and technical teachers in West Virginia. The extent to which any generalization can be considered must be

limited to subjects with similar background characteristics to those included in this study.

Findings associated with hypotheses 1 and 2 indicated that there was no significant difference between the three treatment groups when making comparisons for all subjects or for only those who scored less than 58 percent on the pretest. Considerations such as availability of materials, equipment, class size, student preference, and student learning style may be overriding factors in making decisions regarding the instructional delivery system for math training for industrial and technical teachers.

#### Improving the Teachers' Math Skills

The math skills of teachers participating in this study were increased substantially through short-term review and remediation by all three instructional approaches. Teachers with lower math skills seemed to benefit most from review and remediation. Percent pretest to posttest mean gain was 9.72 percent for all subjects, while participants scoring less than 58 percent on the pretest achieved a mean gain of 19.03 percent.

Although there were substantial gains realized between pretest and posttest scores, math review and remediation provided did not appear to be enough for many of the



participants. The mean posttest score for those scoring less than 58 percent on the pretest was 52.47 percent while the minimum score required for the issuance of a vocational teaching certificate is 58 percent. Of those persons scoring less than 58 percent on the pretest, 16 (19%) scored above 58 percent on the posttest. Thirty-one participants failed to reach the minimum 58 percent level.

Some evidence suggests that a substantial percentage of non-degree industrial and technical teachers are weak in basic math skills as measured by the CAT tests. The mean pretest score for the subjects of this study ( $N=84$ ) was 54.52 percent while the mean score for participants of the 1987 pilot study ( $N=184$ ) was 58.26 percent. These two groups, in combination, represent about 40 percent of all industrial and technical teachers in West Virginia who have less than a four-year degree. CTB/McGraw Hill describes the objectives tested on the CAT tests as those generally taught in grades 10.6 through 12.9. Data collected in this study suggest that a substantial portion of industrial and technical teachers may have a lower competency level for formal basic math skills than students are expected to have. For example, the grade equivalent for 44.91 percent, which was the mean pretest score for the 47 subjects addressed by hypothesis 2, was nine years and three months (9.3 grade equivalent). Although they may possess

acceptable applied math skills within their occupational specialty most teachers in the study population needed review and remediation in the area of formal basic math skills. Forty-seven (56 percent) of the participants scored below the state minimum score for the issuance of a vocational teaching certificate. Eighty-one percent of the teachers participating in this study indicated that they had not had formal math instruction since high school. Using the mean age of 46.36 years and an assumed high school graduation age of 18 years, it can be determined that the mean years since formal math instruction for teachers participating in this study was approximately 27.64.

The lack of formal math training since high school may account for low pretest scores by many of the participants. This is supported in part by the moderate, negative correlation ( $r = .408$ ) between age and pretest scores ( $N = 84$ ). Other background characteristics examined in this study were not significantly related to the teachers' success on the pretest. Results of the course evaluation were not significantly higher for any one of the three treatment groups when comparing selected items of the course evaluation instrument. For the subjects of this study, this suggests flexibility in meeting the needs of the teachers in regard to group preference for instructional approach.

## Advantages and Disadvantages of Each Instructional Approach

Since there was no significant difference in adjusted posttest mean scores when comparing treatment groups of this study, other considerations should be taken into account when selecting the appropriate instructional approach for providing basic math skills training. The following is a discussion of the advantages and disadvantages observed regarding the three instructional approaches used in this study.

Computer Assisted Instruction (CAI). Although mean CAI posttest scores were not significantly higher than the ILM or LEC groups, CAI did possess certain characteristics that theoretically can be considered advantages to its use as an approach to math instruction. Four such advantages to using Skills Bank included 1) immediate feedback to participants, 2) diagnostic capability, 3) student records management, and 4) instructional modeling in the use of CAI.

To provide immediate feedback, the CAI program used several techniques including optional hints during drill and practice, immediate quiz and test results, and continual progress reports. A diagnostic feature selected subsequent lesson assignments based on a pretest. A record of the students progress was also a built-in capability of Skills Bank. This record keeping capability included scores achieved

on previous tests, number of responses correct on a first and second try, as well as a graph showing relative progress.

For most participants, this instruction was their first exposure to CAI. Responses to the course evaluation indicated that participants were receptive to this method of learning. Participants in CAI were exposed to a good model of computer assisted instruction and, therefore, would probably be more likely to use computer assisted instruction as an instructional tool in the classroom.

A disadvantage to CAI, experienced in this study, was the necessity to use Skills Bank on a local network system. Networking allows a group of students to share the same software through a communication system designed to link several computers together. Although networking was advantageous in regard to cost for software, it did require the presence of an instructor and the availability of a computer laboratory with networking capability. This restricted the availability of the computer laboratory to the participants to three hours per week during the regularly scheduled class sessions. The alternate approach of purchasing multiple copies of software or a site license was cost prohibitive.

Another disadvantage to CAI experienced in this study was that the selection of software was restricted to the

capability of the computer hardware available. In order to use many of the more technically advanced software packages, the hardware must include the appropriate accessories along with adequate memory. Many of the computers in the public school systems simply are not equipped to take advantage of sophisticated software features that are designed to make CAI learning more efficient and effective.

Individualized Learning Modules (ILM). Just as there were advantages to using CAI, there were also advantages to the ILM approach. These advantages included 1) low initial cost, 2) only limited access to a teacher is needed, 3) participants do not have to deal with their fear of computers, and 4) learners can work at their own pace in their chosen learning environment.

ILM materials were somewhat inexpensive at a cost of approximately twenty dollars per participant. Since the modules were designed for self-study, only limited access to a teacher was needed. This could greatly reduce the cost of faculty time to teach as compared to a traditional lecture situation.

Many entering teachers may not have basic computer skills and may experience additional pressure when faced with learning to use the computer while learning math. As a

result, they may tend to avoid the math instruction because of a fear of computers, or they may avoid attendance of formal classes because of a fear of being embarrassed. Written form individualized learning modules provide those individuals with a private way to master basic math skills without the pressures a traditional classroom setting may impose upon them.

A disadvantage associated with ILM was that the "Success in Mathematics" series were not designed to be reused. The ILM approach required writing and computation within the modules. Since materials cannot be reused, the cost per person trained would be repeated each time a new person entered training. With CAI software, the material can be used over and over again without additional material cost.

Another disadvantage to using the ILM approach is that its success is dependent on the student's motivation to work independently. All students may not be sufficiently motivated to work on their own. All three adjunct faculty providing instruction through the ILM approach voiced a concern that some members of their group lacked motivation to work on their own.

Lecture (LEC). Some students will always prefer the traditional lecture method. A major advantage for the LEC

approach observed during this study was the students' ability to interact with the instructor when mathematical concepts were not fully understood. With the CAI and the ILM approaches, student interaction with the instructor and other class members was not as frequent because the instructional approaches were designed to encourage learning with only limited access to an instructor. Perhaps a major reason for the preference of the LEC approach by some participants was that most of their formal education was gained through the traditional lecture approach, and therefore they are more at ease with learning through the traditional lecture method.

Another major advantage of the LEC approach observed was that the student's commitment to attend class reserved a block of learning time per week. Although this was also true with the CAI approach in this study, it may not be true for other applications of CAI where students do not meet in a computer lab as a group.

As indicated by pretest scores and the varied background characteristics of participants, there were many different levels of ability and achievement within groups who participated in this study. A major disadvantage to the LEC approach was the difficulty in meeting individual needs of the participants. Lectures had to be geared to the needs of the majority of the class members, sometimes failing to address

the needs of the faster or slower learner.

Another disadvantage to the LEC approach is the costs associated with providing instruction. With the traditional lecture, both an instructor and a classroom is needed for each class meeting. Although an instructor was present for each class meeting for the CAI participants, it was mainly to facilitate the use of CAI software that was provided through a computer lab with a local network.

#### The California Achievement Test

The measuring instruments used in this study for the pretests and posttests were designed to measure mathematics concepts and applications. However, those applications were not occupationally specific to the industrial and technical teacher's teaching specialization. It is possible that some of the participants' low scores may be attributed to the academic nature of some of the questions of the pre and post tests. For example, some teachers considered to be very competent in applying math to tasks performed on the job in an occupational setting, may not have had a need to develop an understanding of number theory. Also, many "rule-of-thumb" math computations may have been substituted for more exact computations where exact calculations were not critical.



For example, in the construction trades the estimation of materials needed for the completion of a project may include a consideration for waste which may also serve to cover an under estimate of material needed. Even when the estimator is wrong, there are usually options to return extra material or buy more.

### Recommendations for Future Research

Several possibilities exist for additional research related to this study:

1. Analyze and compare future CAI software packages that are introduced for basic skills instruction in the area of math. A past criticism of the microcomputer for providing math instruction through CAI was the limited memory available in microcomputers. Advancing technology has given microcomputers the capability to operate software programs that formerly could only be operated on a mainframe computer. As a result, many publishers of software are greatly expanding their efforts to meet a greater array of educational needs.
2. As mentioned previously, CAI software is becoming more and more sophisticated in incorporating instructional techniques. The use of enhancements, such as color, graphics, animation, and special effects, need to be

researched to determine if they make a significant difference in instructional effectiveness.

3. A replication of this study should be conducted in the future when one or more of the following may be incorporated into the study:

a) more sophisticated software is available along with computer equipment capable of accommodating that software.

b) participants may be exposed to more clock hours of review and remediation.

c) participants may be randomly assigned to the treatments.

4. Research in the area of assessing and improving basic reading and writing skills for non-degree industrial and technical teachers is recommended. According to a previously discussed pilot study (West Virginia Department of Education, 1988a), basic math skills seemed to be the weakest basic skills area; however, many teachers had trouble in the area of reading comprehension and language expression as well.

5. Research designed to identify the basic skills needed by a worker within specific occupations is needed. This research could contribute much to curriculum development efforts designed to infuse basic skills into the

instructional program.

6. A national study designed to determine current state competency testing requirements for entering, non-degree, industrial and technical teachers is needed.
7. Research designed to study the relationship between the teachers' basic skills and effective teaching could contribute much in making decisions regarding industrial and technical teacher competency testing and teaching effectiveness.
8. The cost effectiveness of providing in-service basic math skills review and remediation to in-service teachers needs to be explored.

#### Implications of the Study

This study represents only a beginning in addressing some of the basic academic foundation needs of non-degree industrial and technical teachers. Because most industrial and technical teachers are non-degree and enter the teaching profession after several years of industrial experience, many may need review and/or remediation in one or more areas of basic skills. Findings of this study, although focused on a comparison of three instructional approaches to providing instruction to teachers, point to a need to address the development of basic skills as a part of personnel development

for non-degree industrial and technical teachers. As states develop and implement teacher competency testing for non-degree industrial and technical teachers, there will be a need to provide opportunities for review and remediation in the basic skills for those who have trouble meeting established standards.

For some program areas in some geographic locations, local school systems have already found it difficult to fill positions. Teacher competency testing requirements may add to the severity of this problem. Because of difficulty in recruiting industrial and technical teachers who already have the basic skills and the occupational experience, industrial and technical teacher certification programs for non-degree teachers may have to include some review and remediation in the basic skills. Also, if the infusion of basic skills into the instructional program is expected the teacher may need to be provided instruction regarding techniques for infusing basic skills into the instructional program.

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## APPENDICES

**APPENDIX "A"**  
**COURSE INTEREST SURVEY FORM**

# TEACHING MATH IN VOC ED

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## COURSE INTEREST SURVEY FOR FALL, 1988 SEMESTER

West Virginia Tech is offering a course entitled "Teaching Math in Vocational Education" for the Fall 1988 semester. This course will consist of a review of basic mathematical concepts and applications as well as methods and techniques for the teaching of math as a part of the vocational curriculum. Classes will begin during the second week of September and end during the second week of December. Class sessions will be held once a week with each session lasting three hours. Three semester hours of *OCCUPATIONAL UPDATE CREDIT* will be granted for successful completion. A limited number of site locations will be identified for participation, based on returns received from this survey. If you are interested in this course being conducted at your school, please complete the survey form below and return by March 20, 1988. Your assistance in recruiting other Industrial, Technical and Health Occupations teachers in your area will help to increase the chances of this course being offered in your school.

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### SURVEY RESPONSE

I am interested in participating in your course entitled "Teaching Math in Vocational Education" for the Fall 1988 semester. Please consider our school as a possible site for a course offering.

Send survey  
response to:

Nolan Browning, Chairman  
Department of Vocational-Technical Education  
West Virginia Tech  
Montgomery, West Virginia 25136

Name \_\_\_\_\_ School \_\_\_\_\_ Date \_\_\_\_\_

**APPENDIX "B"**  
**COURSE INTEREST SURVEY SUMMARY**



## Appendix B

### Table B-1

#### Teaching Math in Vocational Education Survey Summary

County or School	No. of Participants
Summers .....	5
Fayette .....	7
Romney .....	8
Huttonsville .....	3
Wayne Co. South .....	8
Mason .....	9
PRT .....	4
Cabell .....	16
RR Willis .....	11
U.C.C. ....	4
South Branch .....	4
Barbour .....	4
Putnam .....	14
Anthony Corr. Center .....	11
WV Rehab Ctr. ....	9
Monroe .....	5
Wheeling Park .....	7
Boone .....	3
Doddridge .....	1
Randolph .....	9
Tucker .....	5
Wetzel .....	2
Arch Moore R/J .....	8
James Rumsey .....	9
Ben Franklin .....	9
John Marshall .....	6
Brooke .....	1
Mineral .....	7
McDowell .....	7
Raleigh .....	5
Marion .....	6
<b>Total =</b>	<b>208</b>

**APPENDIX "C"**  
**STUDENT REACTION TO INSTRUCTOR AND COURSE FORM**

STUDENT REACTION TO INSTRUCTOR & COURSE

COURSE \_\_\_\_\_ INSTRUCTOR \_\_\_\_\_ DATE \_\_\_\_\_

Each of the items below deals with a characteristic of instructors which students feel to be important. Indicate your rating of your instructor by a check in the appropriate space on the scale to the right of the question or mark the corresponding number on the accompanying card. (Verbal instructions will indicate which procedure is to be used).

If this course is a lecture course, answer the first 19 questions. If this course is a lecture course with a laboratory, answer all questions. If this course is a non-lecture course (lab, design, graphics, project, etc.), answer all the starred questions. In all cases answer questions 24 & 25 and the questions on the back of this sheet. (Verbal instructions will be given as to which of these procedures to follow).

- \*1. Is course material presented in an interesting manner?  

A	B	C	D	E
very interesting				dull
- \*2. Are students able to get personal help from the instructor when needed?  

A	B	C	D	E
always				never
- 3. Are students encouraged to participate in class discussions?  

A	B	C	D	E
always				never
- \*4. Are course objectives and work requirements well defined?  

A	B	C	D	E
well defined				poorly defined
- \*5. Is grading in this course fair and impartial?  

A	B	C	D	E
yes				no
- 6. How much has this instructor increased your knowledge and competence in this subject area?  

A	B	C	D	E
very much				none
- 7. Are the presentations intellectually stimulating? (Do they cause you to think?)  

A	B	C	D	E
yes				no
- \*8. How much are you learning from this course?  

A	B	C	D	E
very much				very little
- 9. Is course material presented clearly?  

A	B	C	D	E
very clear				not clear
- 10. Would you recommend this instructor to a student whose interests are like yours?  

A	B	C	D	E
yes				no
- 11. Does the instructor seem to know the subject matter of the course?  

A	B	C	D	E
yes				no
- \*12. Does the instructor seem concerned about each student's progress?  

A	B	C	D	E
yes				no
- 13. Does the instructor raise challenging questions in class discussions?  

A	B	C	D	E
often				rarely
- \*14. Is the instructor's grading system well defined?  

A	B	C	D	E
well defined				poorly defined
- 15. Has this instructor increased your interest in the subject?  

A	B	C	D	E
yes				no
- 16. Is there good agreement between the objectives of this course and what is actually being taught?  

A	B	C	D	F
good agreement				poor agreement
- 17. Considering everything, how do you rate the instruction in this course?  

A	B	C	D	E
very good				very poor
- \*18. Optional question by instructor.  

A	B	C	D	E
---	---	---	---	---
- \*19. Optional question by instructor.  

A	B	C	D	E
---	---	---	---	---

The following questions for Lab and Other Non-Lecture Courses  
 Lab Instructor's Name \_\_\_\_\_

- \*20. Do you feel the assigned tasks are relevant?  

A	B	C	D	E
yes				no
- \*21. Do you believe your time was well spent?  

A	B	C	D	E
yes				no
- \*22. Are instructions adequate and sufficiently clear?  

A	B	C	D	E
yes				no
- \*23. Does preparation of required reports have reasonable educational value?  

A	B	C	D	E
very much				very little

General Information

- \*24. Your grade point average?  

4.0-3.4	3.3-2.8	2.7-2.3	2.2-2.0	1.9-0.0
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- \*25. What grade do you expect to get in this course?  

A	B	C	D	F
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