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Title: THE RELATIONSHIP OF TEACHERS' MATHEMATIC PREPARATION AND DEGREE LEVEL TO ESSENTIAL LEARNING SKILLS

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Organizations leading education reform of the 1980's have challenged teacher education programs at colleges and universities across the nation to improve the subject matter content preparation of teachers. Past methods of program development and techniques to assess teacher's knowledge competence have been one-sided in their approach. New research studies on expert vs novice teachers show that expert teachers are more efficient in carrying out standard patterns of instruction.

This nation's mathematics community has engaged in a revitalization of mathematics curricula. Traditional mathematics is being transformed to become a powerful science. Using the growing body of research, the National Council of Teachers of Mathematics have developed standards for improving the teaching and learning of mathematics.

Oregon's Department of Education has also established standards to meet the needs of a changing mathematics curricula and the challenges of a changing society.

This study identified the specific content knowledge taught in the mathematics curricula within colleges and universities which offer four, five or fifth year teacher education programs. It then compared these findings against teacher identified origins of elementary, middle and high school teachers' mathematics content knowledge relative to the Essential Learning Skills of Oregon.

It was found that teachers' content knowledge of the Essential Learning Skills of Oregon was not directly related to their preparation as teachers; at the elementary and high school levels, there was no direct relationship found between teachers' degrees and their teaching assignment; there was no apparent relationship between teachers' knowledge of the Essential Learning Skills of Oregon and graduation from an Oregon college or university; there was no apparent relationship between teachers' lack of knowledge of the Essential Learning Skills of Oregon and graduation from a non-Oregon college or university.

THE RELATIONSHIP OF TEACHERS' MATHEMATICS PREPARATION AND DEGREE LEVEL TO ESSENTIAL LEARNING SKILLS

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Typed by researcher for Gerald M. Balaban

TO MY PARENTS

This dissertation is dedicated to Mike and Elva Balaban. Their love and caring continue to be the guide-posts to my successes.

If one advances confidently in
the direction of his dreams,
and endeavors to live the life
which he has imagined,
he will meet with a success
unexpected in common hours.
...If you have built castles in the air,
your work need not be lost;
that is where they should be.
Now put foundations under them.

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> Knowledge is the only instrument of
> production that is not subject to
> diminishing returns.
>
> J.M. Clark

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> There is no meaning to life
> except the meaning man gives
> to his life by the unfolding
> of his powers.
>
> Erich Fromm

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CHAPTER I

INTRODUCTION

"Education is the acquisition of the art of the utilization of knowledge" (Whithead p.4). What type of knowledge and how this knowledge is passed on remains one of the critical questions being asked by the modern educational institution. Educational reformists of the 1980's have called for a return to the teaching of basics: reading, writing and arithmetic. They are concerned with students' lack of essential knowledge and basic skills considered necessary prerequisites for success in the more diversified technological society of the future (Boyer 1987, Toffler 1980) Educational institutions have sought to implement new curricula, instructional methods, and/or programs as a means of introducing students to the essential knowledge and skills applicable to life beyond public school (Boyer 1987)

For some reformers, educational priorities and interests have diminished the intellectual quality of the educational experience by equating skill development with education and paying too little attention to content knowledge. They conclude that many present day educators believe it is more important to teach students "how to" than "what to" learn. This process of acquiring skills merely develops certain techniques and strategies and does not relate to specific content. (Ravitch, Finn 1987, Cheney, 1987)

Educational formalists have overlooked the importance of content, and this neglect has left us with a sagging national literacy level. "The great hidden problem in American education is education's failure to provide students access to the diverse background of information that forms the foundation of literacy" (Hirsch 1987, p. 1).

This diverse background is more than the reading of textbooks, or the "Great Books" as advocated by Allan Bloom (Bloom, 1987). It is the specific subject matter knowledge brought to the classroom by teachers, the organizational and representational structures of that knowledge, and the identification of the knowledge which has the most value.

One recommendation of the Holmes Group, a current teacher education reform organization, is to give greater attention to the idea of increasing the subject matter competence of teachers. They theorized there is a direct relationship between the "quality of teachers and the quality of their education" (Holmes Group 1986, p.23). Mortimer Adler maintains that the quality of student learning depends largely upon the quality of the teaching and further asserts that present teacher-training programs are producing teachers who are ill-equipped with basic knowledge, intellectual skills, or who have not developed the understanding needed to guide and help young people in a course of study needed in a complex and technical world.

This study seeks to analyze the relationship of teachers' mathematical content preparation and the origins of their knowledge with the Essential Learning Skills of Oregon.

The essential learning skills, organized into seven categories, define selected learning outcomes necessary for success in today's Information Age. For the purpose of this study, mathematics, one of the essential learning skills was selected for investigation.

PURPOSE OF THE STUDY

The purpose of this study was to identify the specific content knowledge taught in the mathematics curricula of undergraduate or graduate teacher education programs within colleges and universities which offer four, five or fifth year teacher education programs.

OBJECTIVE OF THE STUDY

The principle objective of this study was to compare the acquistion of elementary, middle and high school teachers mathematics content knowledge with their preparation within representative training programs, as this knowledge pertains to the Essential Learning Skills of Oregon.

SIGNIFICANCE OF THE STUDY

National and blue ribbon commissions, panels of experts, and research institutions reasoned teachers must have a stronger academic background in specific subject matter. They have emphasized the perceived problem of poor academic preparation of teachers by citing declining SAT scores, an unacceptable high school student performance and drop-out rate, and millions of illiterate adults. (College Board 1984, Hahn 1987, Hirsch 1987, Ravitch, Finn 1987.)

The Holmes Group consortium indicates that prospective teachers are offered coursework concentrations in general or specific subjects. There is a lack of depth and consistency of program offerings and curricula. Little is encountered or learned from these academic studies, for there appears to be limited common substance to education program curriculum. (Holmes 1986, Conant, 1963)

Lee Shulman (1986) found that the specific subject matter knowledge of teachers has been alluded to, but has not been studied in depth. Studies by Wilson, Shulman and Rickert maintain that researchers are "unclear what teachers know about their specific subject matter" (1987, p. 108). Shulmam further asserts that subject matter has been viewed as a context variable, "a control characteristic for subdividing data sets in terms of content categories... But no one focused on the subject matter content itself" (1986, p. 8).

In the field of mathematics, experts conclude that students have failed to aquire the skills or concept understanding of mathematics which will enable them to "participate effectively in the cultural, economic, political and scientific environments of the future" (Campbell, Fey, 1988, p. 53).

The present study examined the preparation of teachers assigned the responsibility for teaching mathematics by requesting they identify from which learning environment specific mathematics concept and procedural knowledge was first learned and apprehended. The following hypotheses were developed.

HYPOTHESES

1. There is a direct relationship between teachers' knowledge of the Essential Learning Skills of Oregon and their academic preparation as teachers.
2. There is a direct relationship between teachers' undergraduate and graduate degrees and their teaching assignment.
3. There is a direct relationship between teachers graduating from Oregon institutions of higher education and their knowledge of the Essential Learning Skills of Oregon.
4. There is a direct relationship between teachers graduating from institutions of higher education outside Oregon and their lack of knowledge of the Essential Learning Skills of Oregon.

DESIGN

This study analyzed demographic and survey data gathered from teachers who teach mathematics. A descriptive format summarizes the relationship between the essential learning skills and the educational content knowledge preparation of teachers.

INSTRUMENTATION

The dependent variables for this study were data gathered using a survey-type tool containing 64 items gleaned and/or modified from the Comprehensive Curriculum Goals for Mathematics published in 1987 by the Oregon Department of Education. With the assistance of a middle school mathematics teacher, an initial survey tool with descriptors was developed. Contact was then made with the Oregon Department of Education, and with assistance of the Department's mathematics specialist, the initial survey tool and descriptors were reviewed and modified.

The survey identified nine major mathematical concept and procedural strands or categories:

1. Number and numeration concepts used to read, write, order, compare and use numbers.

2. Appropriate computation skills with manipulatives; mental (in the head), paper/pencil estimation or calculator usage.
3. Problem solving skills and strategies to solve routine and non-routine problems.
4. Geometric concepts and relationships.
5. Measurements to keep records, solve problems and make predictions.
6. Statistics and probability; collect, organize, record and interpret data.
7. Mathematical relationships and logical thinking.
8. Oral and written communication of mathematical concepts.
9. Appropriate study skills to accomplish mathematical learning.

Each of the nine strands consisted of a number of subsets which delineated specific mathematical knowledge.

Descriptors followed each subset item on the survey allowing respondents to identify from which learning environment specific concept and procedural knowledge within the discipline of mathematics was first learned and apprehended. The descriptors were:

PE - Prior education (K-12)

U - Undergraduate

G - Graduate

TE - Teaching experience

Modification and content validity was established through use of a Delphi panel. Five members of the mathematics community known for their expertise in mathematics education were selected by the researcher. Delphi members were contacted in person when possible, with follow-up contacts made by phone or through the mail. Panel members were asked to review and react to the survey tool by accepting, rejecting or modifying each item. Upon return of the survey tool by panel members, a review by the researcher identified and made minor suggested changes. A final tool was compiled and tested. Names, addresses and positions of the Delphi panal members may be found in Appendix A.

PROCEDURES

Contact was made with four school districts in Oregon. These included school districts in Polk, Marion, Lincoln and Yamhill Counties. Two districts in California were also contacted, and their participation requested.

Within each district all middle and high school teachers of mathematics were asked to participate in the study. At the elementary level, a number equivalent to the total sample size at the middle and high school levels were selected to participate on a per district basis.

After receiving authorization from district and building administrators, the researcher made direct, personal contact with school officials and teachers. Meetings were held with teachers of mathematics or officials to explain procedures, time lines, demographic and survey material, and answer any questions.

LIMITATIONS

1. Only teachers whose instructional assignment included the daily teaching of math to students were asked to participate in this study.
2. Responses by participants may have been biased by personal rather than professional beliefs and may not represent a normal distribution.
3. The use of a large and varied sample over a large geographical area made data collection difficult.
4. Introduction and explanation of the

instrument to teachers was controlled by district office and building administrators. This did not allow consistency of control of extraneous or intervening variables during introduction of the instrument.

5. This investigation was confined to a limited population of specific districts chosen by the researcher within Oregon and California.

DEFINITIONS OF TERMS

1. Apprehend: To grasp mentally. To understand.
2. Concept Knowledge: Content of mathematical knowledge. Understandings that underlie a mathematical procedure, such as symbolic representation and descriptive terms, i.e., place value, take away, comparison, partition. Knowledge of properties, relationships and meanings.
3. Content Knowledge: Understanding or ability to recall and do operations of the facts or concepts within a specific subject matter domain.
4. Essential Learning Skills: Know-how skills;

competence in the use of the skill. Basic skills which enable students to continue to learn.

5. Information Society: Civilization where the most basic raw material is information and imagination. Information technologies in communications and computers accelerate the pace of change.
6. Origins: That from which anything derives its existence.
7. Procedural Knowledge: Capability to select or generate and carry out appropriate or necessary plans of action for obtaining a desired result. Knowing what to do, how to do it and when to do it.
8. Specific Subject Matter Content Knowledge: Conceptual and procedural knowledge within individual content disciplines, i.e., math.

CHAPTER II

REVIEW OF LITERATURE

INTRODUCTION

A search of related literature pertaining to teachers' subject matter knowledge was conducted. A review of this literature was organized as follows:

1. Teacher Education.
2. Mathematics Curriculum.
3. Essential Learning Skills of Oregon.
4. Subject Matter Knowledge
5. Summary

TEACHER EDUCATION

In 1983 the United States Department of Education released the report, "A Nation at Risk: The Imperative for Educational Reform". This document criticized the condition of American public schools and played a major role in the beginning of the reform movement of the 1980's. This report recommended:

1. More rigorous coursework requirements for high school graduation.
2. Higher admission standards for universities.

3. Longer school days and years.

4. Merit pay for outstanding teachers.

5. More public participation in schools.

As a result of this report many state governors and legislatures mandated program changes designed to create public "schools of excellence" (Glickman 1987, p. 6). The primary goal of reform was to improve the academic performance of American students.

In 1986 the focus of school reform changed from trying to improve student performance by changing the public school sites and conditions, to improving the preparation and performance of teachers before they begin their career in teaching. The 1986 report, "A Nation Prepared: Teachers for the 21st Century", by the Task Force on Teaching as a Profession of the Carnegie Forum on Education and the Economy was the springboard for the reform of teacher education programs. The report advocated the following:

1. Create of a national board to license teachers.
2. Allow teachers to determine what will be taught in the schools.
3. Establish ranks within the teaching profession.
4. Require a bachelor's degree in arts and science as a prerequisite for enrollment in education courses leading to certification.

5. Reinstate the master of teaching degree.
6. Prepare more minority teachers.
7. Institute merit pay, with student test scores as the basic criterion.
8. Dramatically increase teacher salaries.

Closely aligned to the Carnegie report was "Tomorrow's Teachers: Report of the Holmes Group of 1986". The Holmes Group is a consortium of 96 research universities working together to reform teacher education. Their stated goals are:

1. To make the education of teachers intellectually more solid.
2. To recognize differences in teachers' knowledge, skill and commitment in their education, certification, and work.
3. To create standards of entry to the profession (examinations and education requirements) that are professionally relevant and intellectually defensible.
4. To connect our own institutions to schools.
5. To make schools better places for teachers to work and to learn.

The basic objective of the Holmes Group is to develop "outstanding programs" in teacher education. As a means of accomplishing this task, they urge member universities to implement new agreements between faculty and administrators in the departments of arts and sciences and in the schools of education. Further, the consortium has identified the need for a "synthesis and representation" of existing knowledge to be used in the restructuring of programs in teacher education. In communicating with departments of education on college and university campuses across the nation, the consortium maintains that prospective teachers are offered coursework concentrations on general or specific subjects. A lack of depth and consistency was found in these program offerings and curricula. Little is encountered or learned from these academic studies for there appears to be a limited common substance to teacher education curriculum.(Holmes 1986) In the process of reforming schools of education the consortium states that a "theoretical and empirical knowledge base exists to usefully inform practice and to form a program of professional studies" (Holmes Group 1989, p. i), and that it is with this body that the development of outstanding programs in teacher education will come about.

In her synthesis of research on teacher education, Judith Lanier writes that the uniformity of teacher education program requirements from one institution to another have been characterized as "highly unstable and individualistic", and "the variation among and within courses and workshops at different institutions, as well as in the same institutions over brief periods of time, achieves almost infinite variety" (1986 p. 546).

In 1963, Conant reported that, "It is risky to assume that a holder of a bachelor's degree from an American college has necessarily pursued a recognized subject in depth, or in a coherent pattern" (p. 106).

Recommendations are strong and clear; develop a coherent curriculum strengthening the undergraduate and graduate programs in teacher training programs. Reaching the goal of reforming education curriculum "depends upon engaging in the complex work of identifying the knowledge base for competent teaching, and developing the content and strategies whereby it is imparted" (Holmes 1986, p.49). The heart of the matter is the curriculum, the structure of knowledge and "what knowledge is of most worth" (Holmes 1986, p.51).

Students majoring in education at universities across the nation follow a curriculum which is organized into three basic strands: general education, subject matter concentration, and pedagogical studies. Of these three strands the most neglected are the general education, often called liberal arts studies, and the subject matter concentration. Lanier (1986) comments that "Little is known about what prospective teachers typically encounter or learn from academic study in these areas" (p. 546).

While mathematics education is a significant part of the curriculum, there is little research exploring the origin of a teacher's specific subject matter knowledge and skill which is acquired and used by teachers of mathematics.

MATHEMATICS

In reply to the national need for reform of education, the mathematics community has engaged in an evaluation of U.S mathematics education from kindergarten through graduate studies. Organized by the National Research Council (NRC), studies to identify weaknesses and strengths in the present system as a means of revitalizing mathematics education, are being conducted by the Board on Mathematical Sciences, Mathematical Sciences Education Board and their joint Committee on Mathematical Sciences in the Year 2000 (NRC, 1989)

As a leading participant in the evaluation, Thomas Romburg (1988) explored the curricular process used to determine what is taught in mathematics curricula in the public schools. He concludes that most mathematics curricular decisions are influenced by "curriculum developers, school boards and administrators, publishers, and others interested in what is taught in schools" (p.133). Although curricula developers give attention to the subject matter content of a discipline, the traditional perspective for mathematics curriculum selection and organization has been to treat the discipline as a separate unit of study. Schools appear to be more concerned with separating the subject matter of individual disciplines. Students are taught science separate from math, English, history, etc. The classical view of mathematics is one of a static, mechanical and bounded activity that students engage in by following predetermined rules. (Romberg, 1988, Driscoll, 1988)

The National Research Council (NRC) in a 1989 publication, "Everybody Counts", asserts that traditional mathematics curricula do not mirror the "transformations of mathematics from a core of abstract studies to a powerful family of mathematical sciences" (p. 43). In preparing students for the twenty-first century, NRC promotes the concept that, "Mathematics is more than calculation, and must be more than mastery of arithmetic. Geometry, chance, and change are as important as numbers in achieving mathematical power. More important is a comprehensive flexible view that embodies the intrinsic unity of mathematics: estimation supplements calculation; heuristics aid algorithms; experience balances innovation" (NRC 1989, p. 43).

The National Council of Teachers of Mathematics (NCTM), in developing standards for mathematics instruction, maintains, "the mathematics presented in many textbooks is a vast collection of vaguely related concepts and skills which are to be mastered in a strict order. Each page is written as if it were independent of all other pages. The only apparent objective is that students become competent at performing a special algorithmic procedure which yields correct answers on sets of stereotypical exercises" (NCTM 1987, p. 2).

The NCTM has developed a series of standards for grades K-12 to provide a basis for the improvement of the teaching and learning of mathematics. In response to public concern and a changing technology, NCTM has utilized the growing body of research to lead the move for the reform of mathematics education in American schools. NCTM has empathized five general goals for students:

1. becoming a mathematical problem solver.
2. learning to communicate mathematically.
3. learning to reason mathematically.
4. valuing mathematics.
5. becoming confident in one's ability to do mathematics (NCTM 1987, p. 2).

These goals signify programs in which students will have an opportunity for "numerous and various interrelated experiences which allow them to solve complex problems: to read, write, and discuss mathematics; to conjecture, test, and build arguments about a conjecture's validity; to value the mathematical enterprise, the mathematical habits of mind, and the role of mathematics in human affairs; and to be encouraged to explore, guess, and even make errors so that they gain confidence in their actions" (NCTM 1987 p. 12). The NCTM believes these experiences will provide the framework for exemplary programs in mathematics.

Mark Driscoll, project director at the Education Development Center in Newton, Mass., in supporting the NCTM goals, emphasizes the need for educators to dispel the notion that students learn best by listening to teacher lectures. He asserts that too many "misconceptions about mathematic operations" occur and leave students with a loss of a sense of meaning. In this process too little is done to help students "construct a more powerful and useful meaning for the concept" (Driscoll 1988, p. 3).

ESSENTIAL LEARNING SKILLS

In 1984 the State Board of Education for Oregon adopted the Oregon Action Plan for Excellence. The state's role was to clearly identify common curriculum goals for elementary and secondary education. The aim was to:

1. establish educational standards commensurate with the challenges students will encounter in the future.
2. focus public attention on the essential outcomes of schooling that are expected of all students.
3. mobilize and coordinate the energies of Oregon educators to provide learning experiences that motivate and engage all students.

By December 1985 the Essential Learning Skills for Oregon were approved by the State Board. These skills establish the basic skill and performance expectations in the areas of reading, writing, speaking, listening, mathematics, reasoning and study skills. The Essential Learning Skills are more than the typical basic skills program. "They go beyond 'the three R's' to include learning skills needed in our Information Age" (Essential Learning Skills 1987, p. 1).

The second phase was the development of the Common Curriculum Goals for Mathematics to "define more fully the essentials in a strong mathematics program for all Oregon public schools" (CCGM 1987, p. 1).

The third phase of the program was the development of the Comprehensive Mathematics Curriculum, published in 1987. This document offers specific suggestions for school districts in Oregon as they develop their comprehensive curriculum. Together these three documents represent a curriculum plan for a mathematics program capable of meeting the needs of a technological society. (CCGM 1987)

SUBJECT MATTER KNOWLEDGE

Teachers' subject matter competence has been defined as, "essential to the conduct of the intellectual operation which is the core of teaching" (Tom 1989, p. 59). Thus the assessment of this knowledge has taken on a new importance in teacher preparation. The belief that a codifiable knowledge base for teaching exists continues to grow. (Shulman 1987) Shulman has concluded that teachers have knowledge of human development, school curriculum, and learning processes used to make decisions, however, "it remains unclear what teachers know about their specific subject matter" (p. 108). Research studies have alluded to teachers' subject matter knowledge relative to level, organization, and understanding, but these have not been studied in depth. Existing assessment devices are comprised of multiple-choice tests and observational scales. Further, Shulman has found that subject matter has been viewed as a context variable, "a control characteristic for subdividing data sets in terms of content categories... But no one focused on the subject matter content itself" (1986, p. 8).

The traditional path to teacher knowledge assessment of subject matter has been through written examinations such as multiple choice and essay tests. Examples are the California Basic Educational Skills Test (CBEST) or the National Teachers Examinations (NTE) of general, specific and professional knowledge.

The CBEST was developed to "assess educators' basic reading, writing, and mathematics skills in the English language", and "to meet requirements of laws relating to credentialing and employment" (p. 3). The NTE are described as "standardized, secure tests that provide objective measures of academic achievement for college seniors completing teacher-education programs, and for the advanced candidates who have received additional training in specific fields" (AROC 1988, p. 7). These tests are regularly used to assess teachers' basic skills, knowledge of content and understanding of professional practice and are designed to measure isolated pieces of knowledge within specific subject domains.

Much like the performance assessments used by medical and bar associations, Shulman, Bird and Haertel (1988) have created assessment center exercises to observe teachers as they develop lesson plans, analyze textbooks for use in classrooms, and analyze how teachers respond to errors in student work samples. These performance exercises reflect some of the complexities of teaching, but they do little to assess areas of content as well as the traditional written tests do. They do however simulate more of the complexities of teaching.

Formal evaluations of classroom instruction have been extensively used to measure teacher performance and insure licensors of teacher competence. This process utilizes direct observation methods by applying standardized rating scales. This method is applied to all grade levels and subject areas to analyze teacher presentations and does not address specific content. Observers are often administrators unfamiliar with the subject or content being observed.

More current studies by cognitive psychologists are exploring content knowledge in expert performance. Leinhardt and Smith's (1985) research on math instruction has analyzed teacher performance for lesson structure and teacher subject matter knowledge. The analysis was based on cognitive science research of representational systems. Blending the representational systems of node-link, planning nets and flow charts, one such study found that expert teachers were better able to plan and develop more appropriate mental representations during lesson pre-planning and instruction.

Hashweb (1987) studied the influence of subject matter expertise on the pedagogical reasoning of experienced teachers. He examined how subject matter knowledge affected teachers' transformation of textbook materials to the representations used in explanations of concepts and principles. Hashweb noted that "Knowledgeable teachers had more detailed knowledge of their topic, more knowledge of other discipline entities and more knowledge of ways of relating the topic to other discipline entities" (p. 119). He further states that "the study leads us to view teacher prior knowledge of subject-matter as contributing greatly to the transformation of the written curriculum into an enactive curriculum, a transformation that starts during preactive teaching and is reinforced and completed during interactive teaching" (p. 119).

A study of elementary teachers found that teachers who completed more years of high school and college math courses did progressively better on tests of mathematical understandings. (Pigge, Gibney, Ginther 1967-69, 1975-77)

SUMMARY

Organizations leading education reform of the 1980's have challenged teacher education programs at colleges and universities across the nation to improve the subject matter content preparation of teachers. Past methods of program development and techniques for assessing teacher knowledge competence have been one-sided in their approach. New research studies in expert vs novice teachers show that expert teachers are more efficient in carrying out standard patterns of instruction.

The United States mathematics community has engaged in a revitalization of mathematics curricula. Traditional mathematics is being transformed to become a powerful science. Using the growing body of research, the NCTM has developed standards for improving the teaching and learning of mathematics.

Oregon's Department of Education has also established standards to meet the needs of a changing mathematics curricula and the challenges of a changing society.

The subject matter competence of teachers has been defined as the "essentials to the conduct of the intellectual operation which is the core of teaching" (Tom p. 59). From this the assessment of teachers' subject matter knowledge has taken on a new importance in the preparation of teachers. Decisions about teacher competence have been judged through the use of assessment centers, formal evaluations of classroom instruction, and standardized examinations. More current studies by cognitive psychologists are exploring content knowledge of expert teachers to identify the effects of teachers' subject matter knowledge on the transformation of textbook materials to the representations used in explanations of concepts and principles. The goal of these groups is to improve the preparation and performance of teachers before they begin their careers in teaching.

CHAPTER III

METHODOLOGY AND PROCEDURES

DESIGN

This study analyzes demographic and survey data gathered from selected teachers of mathematics. A descriptive analysis summarizes the relationship between the essential learning skills and the educational program content knowledge preparation of teachers.

INSTRUMENTATION

The dependent variable for this study was a survey-type tool containing 64 items derived and/or modified from the Comprehensive Curriculum Goals for Mathematics published in 1987 by the Oregon Department of Education. The researcher with the assistance of Kay Johnson, math coordinator at Talmadge Middle School for Central School District, Independence, Oregon, developed an initial instrument with descriptors. The instrument identified nine major mathematical concept and procedural strands or categories.

1. Number and numeration concepts used to read, write, order, compare and use numbers.
2. Appropriate computation skills with manipulatives; mental (in the head), paper/pencil estimation or calculator usage.
3. Problem solving skills and strategies to solve routine and non-routine problems.
4. Geometric concepts and relationships.
5. Measurements to keep records, solve problems and make predictions.
6. Statistics and probability; collect, organize, record and interpret data.
7. Mathematical relationships and logical thinking.
8. Oral and written communication of mathematical concepts.
9. Appropriate study skills to accomplish mathematical learning.

Each of the nine strands consisted of a number of subsets which delineated specific mathematical knowledge. Subset items were obtained from the Common Curriculum Goals at grades five, eight, and eleven. Additionally these items reflect both traditional and progressive (new directions of) mathematic concepts.

Descriptors followed each subset item on the instrument allowing respondents to identify from which learning environment specific concept and procedural knowledge within the discipline of mathematics was first learned and apprehended. The descriptors were:

PE - Prior Education (K-12)

U - Undergraduate

G - Graduate

TE - Teaching Experience

N - No knowledge of

After completion of the initial instrument, contact was made with Mr. Don Fineran, mathematics specialist for the Oregon Department of Education and primary facilitator for the development of the Comprehensive Curriculum for mathematics. With his assistance, the initial instrument and descriptors were reviewed and modified.

Futher modification and content validity were then established through use of a Delphi panel. Five members of the mathematics community were selected based on their experience and expertise. Their credentials include college professors of mathematics, mathematics educators and a state curriculum director of mathematics.

Each panel member was asked to review and react to the instrument by accepting, rejecting or modifying each item. Liaison with panel members was continued until group consensus was met. Consensus was established when the responses of the panel members were the same 80% of the time. After consensus was reached by panel members the researcher, in consultation with Mr. Fineran at the State Department of Education, reviewed suggestions and made minor changes. No items were rejected by panel members nor were there any major content changes identified or made. Names, addresses and positions of Delphi members may be found in Appendix A.

After this review, a final instrument was compiled (Appendix B) and tested. A small rural district was used as a sample test site. This process allowed the researcher to identify and to eliminate any potential procedural problems.

PROCEDURES

Preliminary contact was made with four school districts in Oregon which served as sample populations. Populations were determined by the total number of students served by each district. A small district student population was established at 4000 or less. A medium district student population was established at 4001 to 10,000. A large district student population was established at over 10,001. For this study Polk, Lincoln and Marion County school districts were chosen as they met the criterion of districts of small, medium and large sizes repectively. These are diverse unified school districts, serving urban and rural populations, providing educational offerings to kindergarden through grade twelve.

Within each district all middle and high school teachers of math were asked to participate in the study. At the elementary level, a number equivalent to the total sample size at the middle and high school levels were selected to participate per district.

As an addition to the sample population, officials at the California State Department of Education were contacted and asked to assist in identifying districts willing to participate in this study. Two districts, Sacramento City School District and San Juan Unified School District, were identified by state department officals and were contacted by this researcher either by telephone and/or in writing. Names, addresses and positions of individuals contacted are found in Appendix C.

To ensure consistent and uniform data collection, this researcher made direct, personal contact with school officials and teachers. Each instrument contained a cover letter of explanation (Appendix D). After receiving authorization from district and building administrators, meetings were scheduled to explain procedures, time lines, demographic and survey materials and answer any questions.

To accomplish the task of dispersal, the researcher:

1. Traveled to sample districts and made personal contact with school personnel.
2. Met with building administrator or building mathematics coordinator.
3. Reviewed the introduction page and answered questions about the instrument.
4. Provided self-addressed return envelop.
5. Allowed two weeks for response.
6. Participation was voluntary within each district.

A minimum sample size of 100 was set for the study. A total of 265 instruments were sent out to participating school districts with a total of 103 returned. One district in California that had agreed to participate returned the 50 surveys sent to them, as district policy would not allow teacher participation at the time sampling occurred. The researcher was prepared to select alternate districts if the original districts had not cooperated and returned a sufficient number of instruments. The total number of surveys returned at each level are as follows:

Elementary - 25

Middle - 42

High - 36

TREATMENT OF THE DATA

For this study the criteria requires that the response patterns must equal or exceed an 80% level to accept the stated hypothesis.

The standard criterion used for evaluating and accepting/rejecting hypotheses 1, 3, and 4 was that 80% or more of the responses must be in the Undergraduate (U) or Graduate (G) categories.

The standard criterion used for evaluating and accepting/rejecting hypotheses 2 was that 80% of the respondents must have fulfilled the Oregon State University mathematics degree requirements as currently defined. Both coursework and inservice activities were included. At the elementary level the requirement is four courses or 12 hours completed in mathematics. At the secondary level the requirement is 57 hours or 19 courses in mathematics.

CHAPTER IV

ANALYSIS OF DATA

ANALYSIS OF DATA

The purpose of this study was to identify the specific content knowledge taught in the mathematics curricula of undergraduate or graduate teacher education programs within colleges and universities offering four, five or fifth year teacher education programs.

The principle objective of this study was to compare the origins of elementary, middle and high school teachers' mathematics content knowledge with their preparation in undergraduate and graduate teacher training programs as it pertains to their teaching within the parameters of the Essential Learning Skills of Oregon.

The Essential Learning Skills, organized into seven categories, have definite selected learning outcomes necessary for success in today's Information Age. For the purpose of this study one of these areas, mathematics, was selected for investigation.

The researcher in the present study investigated the topic of teacher preparation by asking teachers who were assigned the responsibility of teaching mathematics to identify from which learning environment specific mathematics concepts and procedural knowledge were first learned and apprehended. The following hypothesis were developed:

1. A direct relationship exists between teachers' content knowledge of the Essential Learning Skills of Oregon and their preparation as teachers.
2. A direct relationship exists between teachers' undergraduate and graduate degrees and their teaching assignment.
3. A direct relationship exists between teachers graduating from Oregon institutions of higher education and their knowledge of the Essential Learning Skills of Oregon.
4. A direct relationship exists between teachers graduating from institutions of higher education outside Oregon and their lack of knowledge of the Essential Learning Skills of Oregon.

Contact was made with four school districts in Oregon and two in California which served as sample populations. Populations were determined by the total number of students served by the district. Designated criteria were then used to classify district student populations as small, medium or large.

These districts were asked to participate through completion of the instrument which contained the mathematicial concept and procedural categories data and demograghic information. Within participating districts all middle and high school teachers of mathematics were asked to participate in the study. At the elementary level, a number equivalent to the total sample size at the middle and high school levels were selected to participate per district.

A total of 265 survey instruments were sent out to participating school districts. A total of 103 were completed and returned. One district in California returned the 50 surveys because a district policy forbade participation in research studies at the time sampling occurred. The percentage rate of returns by the participing districts was, District A, 95%; District B, 68%; District C, 55%; District D, 60%; District E, 21%.

A master list of tables of demographic and survey responses of teachers who participated in this study are included at the end of this chapter in tables 6 and 7.

FINDINGS

This study analyzed demographic and instrument data gathered from selected teachers of mathematics. The descriptive type research format summarizes the relationship between the Essential Learning Skills of Oregon and the educational program content knowledge preparation of teachers.

The tables which follow summarize data obtained from the instrument responses. They are presented and analyzed by district and are divided into demographics, course content counts, subject matter strand totals and stated hypotheses with interpretations.

The demographic page identifies the institution of undergraduate work, degree, degree major and minor, the mean score for years of teaching, the mean score for years of teaching math, the range for teaching from least to highest years of experience and the certification held by teachers. Certification identifiers 014 and 016 are for elementary teachers. Basic and advanced are for secondary teachers.

The second page of each table identifies the number of mathematics content courses and inservice activities and the number of education mathematics courses and inservice activities completed by respondents.

The upper portion of the final page, of each set of tables, is a summary total of respondents' answers to the instrument. This consists of descriptors: PE-Prior Education; U-Undergraduate; G-Graduate; TE-Teaching Experience; N-No Knowledge of, and the nine mathematics content strands: 1. Number and numeration concepts used to read, write, order, compare and use numbers; 2. Appropriate computation skills with manipulatives; 3. Problem solving skills and strategies to solve routine and non-routine problems; 4. Geometric concepts and relationships; 5. Measurements to keep records, solve problems and make predictions; 6. Statistics and probability; 7. Mathematical relationships and logical thinking; 8. Oral and written communication of mathematical concepts; 9. Appropriate study skills to accomplish mathematical learning.

The lower portion of the final page are the stated hypotheses with stated outcome. A complete interpretation of the each hypothesis can be found at the end of this chapter.

TABLE 1

DEMOGRAPHICS
DISTRICT A
N=19

College/University(s):		Degree	Major	Minor
Elementary				
WOSC/OCE	1	BA	Elem.Ed	--
	1	BA	Art	--
	1	BA	Elem.Ed	Media
	1	BS	Music/Ed	Elem.Ed
Linfield Col.	1	BS	Bus/Ed	--
	1	BA	Elem.Ed	--
PSU	1	BS	Elem.Ed	--
U Nebraska	1	BA	Psych	--
	N=8			
Middle				
*	1	BS	Elem.Ed	Math
WOSC	1	BS	Elem.Ed	Reading
	1	BS	Math	--
	1	BS	Soc.St	Ed
OSU	1	BS	Math	Ed
	N=5			
High				
*	1	BS	Soc.Sci	Math
*	1	BS	Sci.Ed	Math
WOSC	1	BS	Math	--
	1	BS	Science	Math
U Mankato	1	BS	Math	Physics
U Wisconsin	1	BS	Math	Physics
	N=6			

Grad. Degree			Mean years of Teaching	Mean years of Teaching Math
Elem.	MA/MS	4	14.8	12.0
Middle	MA	1	13.2	8.4
High	MS	3	14.25	12.25

Certification	014+	016++	Basic	Adv	Range**
					7-23
Elem	4		2		1-25
Mid	1	2	2	1	5-20
High			1	3	

*Name of college not given.
**Least to highest years of experience teaching.
+To teach in preprimary through grade nine self-contained elementary and middle/junior high.
++To teach in preprimary through grade nine self-contained elementary through grade nine except for departmental assignments of fifty percent or more in mathematics.

TABLE 1.1

DISTRICT A

<u>Math Courses taken during college</u>:

		*Elem	Mid	High
100	Beginning Algebra	--	3	1
	Intermediate Algebra	1	--	1
	Advanced Algebra	--	--	1
	College Algebra	--	2	3
	Calculus	--	--	4
200	Differential Calculus	--	2	3
	Integral Calculus	--	2	3
	Series and Vector Calculus	--	--	1
	Linear Equations and Matrices	--	1	3
300	Vector Calculus	--	--	1
	Applied Differential Equations	--	--	1
	Geometry	--	2	4
	Linear Algebra	--	2	2
	Theory of Numbers	--	2	4
	Logic	--	1	2
	Intro. to Probability	--	1	2
400	Metric Spaces in Analysis	--	--	2
	Complex Functions	--	--	--
	Variational Problems	--	--	--
	Differential Geometry	--	--	1
	Abstract Algebra	--	2	3
	Theory of Probability	--	1	2
	Total=	1	21	44

<u>Other</u>:

	*Elem	Mid	High
Math Content Inservice	1	--	--

<u>Special Courses in Math Education</u>:

		*Elem	Mid	High
100	Arith. as a Logical Structure	--	--	--
	Informal Geometry	___	--	--
	Elementary Mathematics	6	2	--
300	Problem Solving for Teachers	3	--	2
	Intro. to Probability	___	--	2
	Intro. to Modern Algebra	___	--	2
400	Foundations of Arithmetic	2	--	4
	Found. of Algebra	___	--	2
	Found. of Geometry	___	--	2
	Numerical Analysis	___	--	2
	Total=	11	2	16

<u>Other</u>:

	*Elem	Mid	High
Math Methods Inservice	3	2	2

*N=Elem-8, Middle-5, High-6

TABLE 1.2

DISTRICT A
DESCRIPTOR AND STRAND TOTALS

	PE	U	G	TE	N	
1.	49	4	2	4	1	
2.	32	6	0	18	0	
3.	31	7	6	34	4	
4.	31	7	6	34	4	
5.	36	6	2	21	19	
6.	47	30	14	65	29	
7.	68	16	13	40	12	
8.	114	42	8	28	13	
9.	129	26	7	9	4	
	595	153	54	248	95	TOTALS

PERCENTAGE DISTRIBUTION

DISTRICT A

PE	U	G	TE	N
595	153	54	248	95
52%	13%	5%	21%	8%

HYPOTHESIS 1: Relationship between teachers' knowledge and Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 2: Relationship between teachers' undergraduate and graduate degrees and teaching assignment.
Elementary: **Rejected**
Middle Sch: **Retained/Rejected**
High Sch: **Rejected**

HYPOTHESIS 3: Relationship between teachers graduating from Oregon institutions and knowledge of Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 4: Relationship between teachers graduation from institutions outside of Oregon and their lack of knowledge of the Essential Learning Skills.
Rejected

TABLE 2

DEMOGRAPHICS
DISTRICT B
N=13

College/University(s):		Degree	Major	Minor
Elementary				
WOSC/OCE	1	BA	Elem.Ed	Sci.
OSU	1	BS	Elem.Ed	PE
BYU, Utah	1	BS	Elem.Ed	Child.D.
Linfield	1	BA	Ed.	Spanish
Bowling, Ohio	1	BS	Elem.Ed	--
Dana, Nebr	1	BA	Psych	Soc.
	N=6			
Middle				
WOSC	1	BS	Math	Sec.Ed
	1	BS	Math	Computers
U Washington	1	BS	Math	--
U California	1	BA	Hist.	Spec.Ed
	N=4			
High				
Wash.St.	1	BS	Math	PE
U Portland	1	BS	Math	--
Colorado St.	1	BS	Phys.Sci.	--
	N=3			

Grad. Degree			Mean years of Teaching	Mean years of Teaching Math
Elem.	MA/MS	1	12.6	12.6
Middle	MA	2	9.25	9.25
High	MS	2	20.66	20.66

Certification	014+	016++	Basic	Adv
Elem	5	5		
Mid		1	3	
High			1	1

Range**
2-32
1-18
16-23

*Name of college not given.
**Least to highest years of experience teaching.
+To teach in preprimary through grade nine self-contained elementary and middle/junior high.
++To teach in preprimary through grade nine self-contained elementary through grade nine except for departmental assignments of fifty percent or more in mathematics.

TABLE 2.1

DISTRICT B

Math Courses taken during college:

		*Elem	Mid	High
100	Beginning Algebra	2	3	1
	Intermediate Algebra	1	--	1
	Advanced Algebra	1	1	1
	College Algebra	1	3	3
	Calculus	--	--	3
200	Differential Calculus	--	2	3
	Integral Calculus	--	3	3
	Series and Vector Calculus	--	3	1
	Linear Equations and Matrices	--	3	2
300	Vector Calculus	--	1	1
	Applied Differential Equations	--	1	3
	Geometry	1	2	3
	Linear Algebra	--	2	2
	Theory of Numbers	--	2	2
	Logic	--	1	2
	Intro. to Probability	--	2	3
400	Metric Spaces in Analysis	--	--	2
	Complex Functions	--	--	1
	Variational Problems	--	--	--
	Differential Geometry	--	1	1
	Abstract Algebra	--	2	3
	Theory of Probability	--	2	2
	Total=	6	34	47

Other:

	*Elem	Mid	High
Math Content Inservice	1	2	--

Special Courses in Math Education:

		*Elem	Mid	High
100	Arith. as a Logical Structure	--	--	--
	Informal Geometry	--	1	--
	Elementary Mathematics	5	1	--
300	Problem Solving for Teachers	--	2	--
	Intro. to Probability	--	--	--
	Intro. to Modern Algebra	--	--	1
400	Foundations of Arithmetic	1	--	1
	Found. of Algebra	--	--	--
	Found. of Geometry	--	1	--
	Numerical Analysis	--	1	--
	Total=	6	6	2

Other:

	*Elem	Mid	High
Math Methods Inservice	1	1	2

*N=Elem-6, Middle-4, High-3

TABLE 2.2

DISTRICT B
DESCRIPTOR AND STRAND TOTALS

	PE	U	G	TE	N	
1.	34	5	0	4	1	
2.	55	9	1	0	0	
3.	39	19	6	18	0	
4.	70	21	0	13	0	
5.	24	14	3	13	5	
6.	41	53	14	29	13	
7.	51	31	4	25	6	
8.	58	48	26	31	9	
9.	67	41	11	20	3	
	439	241	65	153	37	TOTALS

PERCENTAGE DISTRIBUTION

DISTRICT B				
439	241	65	153	37
47%	26%	7%	16%	4%

HYPOTHESIS 1: Relationship between teachers' knowledge and Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 2: Relationship between teachers' undergraduate and graduate degrees and teaching assignment.
Elementary: Rejected
Middle Sch: Retained/Rejected
High Sch: Rejected

HYPOTHESIS 3: Relationship between teachers graduating from Oregon institutions and knowledge of Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 4: Relationship between teachers graduation from institutions outside of Oregon and their lack of knowledge of the Essential Learning Skills.
Rejected

TABLE 3

DEMOGRAPHICS
SCHOOL C
N=47

College/University(s):		Degree	Major	Minor
Elementary				
WOSC/OCE	1	BA	Elem.Ed	--
*	1	BA	Home Ec.	Ed
*	1	BS	Elem Ed	Sci.
*	1	BA	Ed Psy.	Eng.
BYU, Utah	1	BS	Home Ed	Lang.A.
R.C., Calif.	1	BA	Lib.Art	Early Ch.
	N=6			
Middle				
WOSC/OCE	1	BS	Elem.Ed	--
	1	BA	Ed	PE
	1	BS	Art	--
	1	BS	Math	Ed
	1	BS	Math	PE
	1	BS	Sci.	Math
OSU	1	BS	Math	--
	1	BS	Bio.	Gen.Sci.
	1	BS	Indus.Art	Crafts
U Oregon	1	BS	Math	PE
	1	BS	German	Sci./Soc
Willamette	1	BS	Sci.	Earth Sci
	1	BS	Math	--
U Washington	1	BA	Hist	Math
Stanford	1	BA	German	Soc.Sci.
U Redlands	1	BA	Comm.	Elem.Ed
Lewis & Clark	1	BS	Sociology	Ed
PSU	1	BS	Hist.	Math
Illinois	1	BS	Elem.Ed	--
Wisconsin	1	BS	Elem.Ed	--
Germany	1	BS	Elem.Ed	--
	N=21			

*Name of college not given.

TABLE 3 - Continued

SCHOOL C

High				
WOSC	1	BS	Math	--
	1	BS	Math	PE
	1	BS	Math	Ed
	1	BS	Math	PE
	1	BS	PE	--
	1	BS	PE	Math
	1	BS	Sec.Ed	Math
OSU	1	BS	Bus.Ed	Math
	1	BS	Math	--
Willamette	1	BS	Math	Comp.Sci
*	1	BA	Math	Soc.Sci.
*	1	BA	Math	Ed
*	1	BA	Bus.Ed	Math
UCLA, Ca.	1	BA	Music	Math
Cal.St.,LA	1	BA	PE	Chem.
San Jose, Ca.	1	BA	Antro.	Math
Ball State	1	BS	Math	Sci.
Ohio State	1	BS	Math	Sci.
Washington St.	1	BS	Chem.	Ed
American,Wash.DC	1	BA	Math	Phil/Rel.
	N=20			

Grad. Degree			Mean years of Teaching	Mean years of Teaching Math
Elem.	MA/MS	3	10.2	8.0
Middle	MA	9	11.44	7.9
High	MS	14	16.77	16.38

Certification	014+	016++	Basic	Adv	Range**
Elem	3	1	1		5-18
Mid	2	2	8	4	1-29
High		1	2	14	5-32

*Name of college not given.
**Least to highest years of experience teaching.
+To teach in preprimary through grade nine self-contained elementary and middle/junior high.
++To teach in preprimary through grade nine self-contained elementary through grade nine except for departmental assignments of fifty percent or more in mathematics.

TABLE 3.1

SCHOOL C

Math Courses taken during college:

		*Elem	Mid	High
100	Beginning Algebra	--	4	--
	Intermediate Algebra	--	8	4
	Advanced Algebra	--	4	1
	College Algebra	--	11	7
	Calculus	--	13	20
200	Differential Calculus	--	9	16
	Integral Calculus	--	8	12
	Series and Vector Calculus	--	3	9
	Linear Equations and Matrices	--	6	11
300	Vector Calculus	--	--	4
	Applied Differential Equations	--	5	10
	Geometry	--	10	18
	Linear Algebra	--	7	14
	Theory of Numbers	--	5	13
	Logic	--	5	9
	Intro. to Probability	--	8	11
400	Metric Spaces in Analysis	--	1	1
	Complex Functions	--	1	3
	Variational Problems	--	--	--
	Differential Geometry	--	1	1
	Abstract Algebra	--	4	14
	Theory of Probability	--	6	8
	Total=	0	115	186
Other:				
	Math Content Inservice	--	--	--

Special Courses in Math Education:

		*Elem	Mid	High
100	Arith. as a Logical Structure	--	2	1
	Informal Geometry	1	3	2
	Elementary Mathematics	3	8	2
300	Problem Solving for Teachers	1	7	6
	Intro. to Probability	--	3	3
	Intro. to Modern Algebra	--	2	4
400	Foundations of Arithmetic	--	2	5
	Found. of Algebra	--	4	3
	Found. of Geometry	--	2	7
	Numerical Analysis	--	--	3
	Total=	5	33	36
Other:				
	Math Methods Inservice	--	10	10

*N=Elem-6, Middle-21, High-20

TABLE 3.2

DISTRICT C
DESCRIPTOR AND STRAND TOTALS

	PE	U	G	TE	N	
1.	133	5	4	1	0	
2.	247	7	1	38	1	
3.	149	30	10	48	5	
4.	294	24	10	38	19	
5.	122	20	4	28	18	
6.	157	174	58	59	24	
7.	247	63	8	48	24	
8.	357	107	20	50	23	
9.	331	81	23	26	10	
	2037	511	138	336	124	TOTALS

PERCENTAGE DISTRIBUTION

DISTRICT C					
	2037	511	138	336	124
	65%	16%	4%	11%	4%

HYPOTHESIS 1: Relationship between teachers' knowledge and Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 2: Relationship between teachers' undergraduate and graduate degrees and teaching assignment.
Elementary: Rejected
Middle Sch: Retained/Rejected
High Sch: Rejected

HYPOTHESIS 3: Relationship between teachers graduating from Oregon institutions and knowledge of Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 4: Relationship between teachers graduation from institutions outside of Oregon and their lack of knowledge of the Essential Learning Skills.
Rejected

TABLE 4

DEMOGRAPHICS
DISTRICT D
N=15

College/University(s):		Degree	Major	Minor
Elementary				
CSUS	1	BA	Soc.	Hist.
*	1	BA	Lib.Arts	--
San Francisco St.	1	BA	Elem.Ed	--
Evergreen	1	BS	Psych	Child Dev.
Ohio	1	BA	Elem.Ed	--
	N=5			
Middle				
*	1	BA	PE	--
U.C. Berkeley	1	BA	Pol.Sci.	--
	1	BA	Hist.	--
CSU Sac.	1	BS	Bio.	Chem.
	1	BA	PE	Sci.
UC Davis	1	BA	Music	Math
	N=6			
High				
B College	1	BA	Math	--
UC Berkeley	1	BA	Soc.Sci.	--
	1	BA	PE	Math
UC Davis	1	BA	Phil.	--
	N=4			

Grad. Degree			Mean years of Teaching	Mean years of Teaching Math
Elem.	MA/MS	1	12.2	11.8
Middle	MA	1	8.5	6.33
High	MS	3	19.5	17.0

Certification	Elem+	Sec++	Range**
Elem	5		4-26
Mid	3	3	3-17
High	2	4	13-30

*Name of college not given.
**Least to highest years of experience teaching.
+To teach in preprimary through grade nine self-contained elementary and middle/junior high.
++To teach in the specified subject matter in grades five through twelve.

TABLE 4.1

DISTRICT D

Math Courses taken during college:

		*Elem	Mid	High
100	Beginning Algebra	2	--	1
	Intermediate Algebra	1	1	1
	Advanced Algebra	--	--	2
	College Algebra	1	3	1
	Calculus	--	4	3
200	Differential Calculus	--	2	3
	Integral Calculus	--	1	3
	Series and Vector Calculus	--	1	2
	Linear Equations	--	1	2
300	Vector Calculus	--	--	2
	Applied Differential Equations	--	--	1
	Geometry	--	1	3
	Linear Algebra	--	2	2
	Theory of Numbers	1	3	3
	Logic	--	1	2
	Intro. to Probability	1	1	3
400	Metric Spaces in Analysis	--	--	2
	Complex Functions	--	--	2
	Variational Problems	--	--	1
	Differential Geometry	--	--	2
	Abstract Algebra	--	--	3
	Theory of Probability	--	--	2
	Total=	6	20	48
Other:				
	Math Content Inservice	2	4	4

Special Courses in Math Education:

		*Elem	Mid	High
100	Arith. as a Logical Structure	1	--	--
	Informal Geometry	--	--	1
	Elementary Mathematics	2	3	--
300	Problem Solving for Teachers	1	2	--
	Intro. to Probability	1	--	2
	Intro. to Modern Algebra	--	--	1
400	Foundations of Arithmetic	--	2	1
	Found. of Algebra	--	--	2
	Found. of Geometry	--	--	1
	Numerical Analysis	--	--	1
	Total=	5	7	9
Other:				
	Math Methods Inservice	3	4	2

*N=Elem-5, Middle-6, High-4

TABLE 4.2

DISTRICT D
DESCRIPTOR AND STRAND TOTALS

	PE	U	G	TE	N	
1.	43	1	0	3	0	
2.	64	7	0	16	0	
3.	28	8	9	39	6	
4.	85	18	8	19	7	
5	25	4	2	25	6	
6.	34	46	22	43	13	
7.	62	32	9	30	4	
8.	117	27	13	27	2	
9.	111	26	6	6	3	
	569	169	69	209	41	TOTALS

PERCENTAGE DISTRIBUTION

DISTRICT D					
	569	169	69	209	41
	54%	16%	6%	20%	4%

HYPOTHESIS 1: Relationship between teachers' knowledge and Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 2: Relationship between teachers' undergraduate and graduate degrees and teaching assignment.
Elementary: Rejected
Middle Sch: Retained/Rejected
High Sch: Rejected

HYPOTHESIS 3: Relationship between teachers graduating from Oregon institutions and knowledge of Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 4: Relationship between teachers graduation from institutions outside of Oregon and their lack of knowledge of the Essential Learning Skills.
Rejected

TABLE 5

DEMOGRAPHICS
DISTRICT E
N=9

College/University(s):		Degree	Major	Minor
Elementary				
none				
Middle				
OSU	1	BS	Math	Comp.Sci.
U Oregon	1	BS	Elem	--
CSU Fullerton	1	BA	Eng.	--
U New Hamp.	1	BA	Elem	--
Washington St.	1	BA	Elem	Math/Sci.
?*	1	BS	Soc.St.	--
High	N=6			
U Oregon	1	BS	Math	--
Pacific U	1	BS	PE	Math
Colorado Col.	1	BA	Music	Math
	N=3			

Grad. Degree			Mean years of Teaching	Mean years of Teaching Math
Elem.	MA/MS	0	.0	.0
Middle	MA	3	14.66	10.6
High	MS	1	9.33	7.66

Certification	014+	016++	Basic	Adv	Range**
					0
Elem	1	1			3-20
Mid		2	1	2	1-14
High			2	2	

*Name of college not given.
**Least to highest years of experience teaching.
+To teach in preprimary through grade nine self-contained elementary and middle/junior high.
++To teach in preprimary through grade nine self-contained elementary through grade nine except for departmental assignments of fifty percent or more in mathematics.

TABLE 5.1

DISTRICT E

Math Courses taken during college:

		*Elem	Mid	High
100	Beginning Algebra	--	2	--
	Intermediate Algebra	--	--	--
	Advanced Algebra	--	--	1
	College Algebra	--	1	--
	Calculus	--	2	1
200	Differential Calculus	--	1	1
	Integral Calculus	--	1	2
	Series and Vector Calculus	--	1	--
	Linear Equations	--	1	--
300	Vector Calculus	--	--	1
	Applied Differential Equations	--	--	--
	Geometry	--	1	2
	Linear Algebra	--	1	2
	Theory of Numbers	--	1	3
	Logic	--	--	2
	Intro. to Probability	--	1	1
400	Metric Spaces in Analysis	--	--	--
	Complex Functions	--	--	--
	Variational Problems	--	--	--
	Differential Geometry	--	--	--
	Abstract Algebra	--	1	2
	Theory of Probability	--	1	2
	Total=	0	15	20

Other:

	*Elem	Mid	High
Math Content Inservice	--	2	2

Special Courses in Math Education:

		*Elem	Mid	High
100	Arith. as a Logical Structure	--	1	--
	Informal Geometry	--	2	2
	Elementary Mathematics	--	3	--
300	Problem Solving for Teachers	--	5	--
	Intro. to Probability	--	2	--
	Intro. to Modern Algebra	--	1	--
400	Foundations of Arithmetic	--	5	1
	Found. of Algebra	--	2	1
	Found. of Geometry	--	2	--
	Numerical Analysis	--	1	--
	Total=	0	24	4

Other:

	*Elem	Mid	High
Math Methods Inservice	--	2	2

*N=Elem-0, Middle-6, High-3

TABLE 5.2

DISTRICT E
DESCRIPTOR AND STRAND TOTALS

	PE	U	G	TE	N	
1.	25	4	1	3	0	
2.	40	5	2	10	1	
3.	14	6	2	26	0	
4.	49	11	5	18	2	
5.	20	4	4	11	1	
6.	25	29	20	36	2	
7.	36	10	12	22	1	
8.	52	25	15	19	1	
9.	54	18	12	11	1	
	315	112	73	156	9	TOTALS

PERCENTAGE DISTRIBUTION

DISTRICT E				
315	112	73	156	9
47%	17%	11%	23%	2%

HYPOTHESIS 1: Relationship between teachers' knowledge and Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 2: Relationship between teachers' undergraduate and graduate degrees and teaching assignment.
Elementary: Rejected
Middle Sch: Retained/Rejected
High Sch: Rejected

HYPOTHESIS 3: Relationship between teachers graduating from Oregon institutions and knowledge of Essential Learning Skills of Oregon.
Rejected

HYPOTHESIS 4: Relationship between teachers graduation from institutions outside of Oregon and their lack of knowledge of the Essential Learning Skills.
Rejected

SUMMARY OF FINDINGS

HYPOTHESIS 1:

> There is a direct relationship between teachers' knowledge of the Essential Learning Skills of Oregon and their academic preparation as teachers.

A comparision of numerical totals of the instrument data descriptors (PE, U, G, TE, and N) resulted in a rejection of the stated hypothesis. Descriptor totals for undergraduate (U) and graduate (G) did not meet or exceed the 80% standard. Teachers maintained that their knowledge of the Essential Learning Skills throughout the nine strands was acquired in a K-12 (PE) or teaching experience (TE) versus in undergraduate (U) or graduate (G) training. The data supports this relationship by a ratio greater than two to one. A percentage rate comparision of strands total (PE,U,G,TE,N) further supports rejection of the stated hypothesis [56.9%(PE) and 15%(TE) to 18%(U) and 5.8%(G)]. See table 7, percentage totals.

HYPOTHESIS 2:

There is a direct relationship between teachers' undergraduate and graduate degrees and their teaching assignment.

ELEMENTARY SCHOOL

An analysis of the number of courses and inservice activities taken by the sample of elementary teachers and the current degree requirements at Oregon State University (OSU) resulted in a rejection of the stated hypothesis. The total number of courses and inservice activities completed by teachers did not meet or exceed the 80% standard.

The 25 teacher responses to demographic data questions at the elementary level revealed that none of these teachers majored or minored in mathematics. See tables 1.1, 2.1, 3.2, 4.1, 5.1. Further analysis revealed that a total of 12 content courses, 27 mathematics education courses, and 11 inservice activities were completed by these teachers.

To meet the bachelor degree requirements at OSU a student in elementary education must complete a total of 12 hours of undergraduate work in mathematics education courses. (OSU General Catalog 1988-90) For the survey sampling of 25 this would be the equivalent of 100 courses. The survey responses revealed a total of 39 courses plus 11 inservice activities were completed by participating teachers.

MIDDLE SCHOOL

Comparison of the middle school sample population with the elementary degree requirements at OSU resulted in a retention of the stated hypothesis. The total number of courses and inservice activities completed by teachers exceeded the 80% standard.

A review of the 42 teacher responses to demographic data revealed 11 majors and 6 minors in mathematics. In addition, 13 majored or minored in related fields of science and computers for a total of 29 teachers (69%) with a background in mathematics.

Using the OSU elementary education degree requirements of 12 hours of undergraduate work in mathematics, the middle school sample of 42 teachers surveyed would need to complete 168 classes. Survey responses show a total of 277 classes completed by the survey population.

A second comparison of the middle school sample population with the secondary degree requirements at OSU resulted in a rejection of the stated hypothesis. The total number of courses and inservice activities completed by teachers did not meet or exceed the 80% standard.

The OSU Colleges of Science and Eduation require 57 hours of undergraduate work in mathematics for a bachelors degree. The middle school sample of 42 teachers surveyed would need to complete 19 courses per teacher. 277 courses were completed by the sample population, or approximately, 6.6 per teacher. This revealed that leaa than 35% of the required number of courses were completed by the sample population.

HIGH SCHOOL

Comparison of the high school sample population resulted in a rejection of the stated hypothesis. The total number of courses and inservice activities completed by teachers did not meet or exceed the 80% standard.

A review of the 36 teacher responses to demographic data revealed 15 majors and 12 minors in mathematics. In addition, 8 teachers majored or minored in related fields of science or computers.

The OSU Colleges of Science and Education require 57 hours of undergraduate work in mathematics for a bachelor degree. The high school sample of 36 teachers surveyed would need to complete 19 courses per teacher. 312 courses were completed by the sample population, or approximately, 9 per teacher. This revealed that less than 50% of the required number of courses were completed by the sample population.

HYPOTHESIS 3

> There is a direct relationship between teachers graduating from Oregon institutions of high education and their knowledge of the Essential Learning Skills of Oregon.

A review of the total population sampled in Oregon revealed that 28% graduated from institutions outside of Oregon.

A comparision of numerical totals of the instrument data descriptors (PE, U, G, TE, and N) resulted in a rejection of the stated hypothesis. Descriptor totals for undergraduate (U) and graduate (G) did not meet or exceed the 80% standard.

Teachers indicated by their instrument responses that their knowledge of the Essential Learning Skills throughout the nine strands was acquired in a K-12 (PE) and teaching (TE) experience as opposed to undergraduate (U) or graduate (G) training. A percentage rate comparision of strand totals (PE,U,G,TE,N) further supports rejection of the stated hypothesis [56.9%(PE) and 15%(TE) to 18%(U) and 5.8%(G)]. See table 7, percentage totals. The data supports this relationship by a ratio greater than two to one.

HYPOTHESIS 4

> There is a direct relationship between teachers graduating from institutions of higher education outside Oregon and their lack of knowledge of the Essential Learning Skills of Oregon.

A comparison of numerical totals of the instrument data descriptors (PE, U, G, TE, and N) resulted in a rejection of the stated hypothesis. Descriptor totals for undergraduate (U) and graduate (G) did not meet or exceed the 80% standard.

Teachers indicated by their responses on the instrument that their knowledge of the Essential Learning Skills throughout the nine strands was acquired in a K-12 (PE) and teaching (TE) experience as opposed to undergraduate (U) or graduate (G) training. A percentage rank comparision of strand totals (PE,U,G,TE,N) further supports rejection of the stated hypothesis. 54%(PE), and 20%(TE), to 16%(U) and 6%(G). See table 4.2, percentage distribution.

TABLE 6

DESCRIPTOR AND STRAND TOTALS

DISTRICT A

	PE	U	G	TE	N	
1.	49	4	2	4	1	
2.	32	6	0	18	0	
3.	31	7	6	34	4	
4.	31	7	6	34	4	
5.	36	6	2	21	19	
6.	47	30	14	65	29	
7.	68	16	13	40	12	
8.	114	2	8	28	13	
9.	129	26	7	9	4	
	595	153	54	248	95	TOTALS

DISTRICT B

	PE	U	G	TE	N	
1.	34	5	0	4	1	
2.	55	9	1	0	0	
3.	39	19	6	18	0	
4.	70	21	0	13	0	
5.	24	14	3	13	5	
6.	41	53	14	29	13	
7.	51	31	4	25	6	
8.	58	48	26	31	9	
9.	67	41	11	20	3	
	439	241	65	153	37	TOTALS

DISTRICT C

	PE	U	G	TE	N	
1.	133	5	4	1	0	
2.	247	7	1	38	1	
3.	149	30	10	48	5	
4.	294	24	10	38	19	
5.	122	20	4	28	18	
6.	157	174	58	59	24	
7.	247	63	8	48	24	
8.	357	107	20	50	23	
9.	331	81	23	26	10	
	2037	511	138	336	124	TOTALS

TABLE 6.1

DESCRIPTOR AND STRAND TOTALS

DISTRICT D

	PE	U	G	TE	N	
1.	43	1	0	3	0	
2.	64	7	0	16	0	
3.	28	8	9	39	6	
4.	85	18	8	19	7	
5	25	4	2	25	6	
6.	34	46	22	43	13	
7.	62	32	9	30	4	
8.	117	27	13	27	2	
9.	111	26	6	6	3	
	569	169	69	209	41	TOTALS

DISTRICT E

	PE	U	G	TE	N	
1.	25	4	1	3	0	
2.	40	5	2	10	1	
3.	14	6	2	26	0	
4.	49	11	5	18	2	
5.	20	4	4	11	1	
6.	25	29	20	36	2	
7.	36	10	12	22	1	
8.	52	25	15	19	1	
9.	54	18	12	11	1	
	315	112	73	156	9	TOTALS

TABLE 7

SUMMARY OF
DISTRICT A TO E STRAND TOTALS WITH
PERCENTAGE DISTRIBUTIONS

DISTRICT A

PE	U	G	TE	N
595	153	54	248	95
52%	13%	5%	21%	8%

DISTRICT B

439	241	65	153	37
47%	26%	7%	16%	4%

DISTRICT C

2037	511	138	336	124
65%	16%	4%	11%	4%

DISTRICT D

569	169	69	209	41
54%	16%	6%	20%	4%

DISTRICT E

315	112	73	156	9
47%	17%	11%	23%	2%

COMBINDED PERCENTAGE TOTALS
DISTRICTS A TO E

PE	U	G	TE	N
56.9%	18%	5.8%	15%	4.3%

TABLE 8

PERCENTAGE DISTRIBUTION
OF TEACHERS GRADUATING OUTSIDE
OREGON AND TEACHING IN OREGON

PE	U	G	TE	N
44%	25%	11%	15%	5%

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to identify the specific content knowledge taught in the mathematics curricula of undergraduate or graduate teacher education programs within colleges and universities offering four, five or fifth year teacher education programs.

The principle objective of this study was to compare the acquistion of elementary, middle and high school teachers' mathematics content knowledge with their preparation within representative training programs, as it pertains to their teaching within the parameters of the Essential Learning Skills of Oregon.

Panels of experts and research institutions, such as the Holmes and Carnegie Groups, maintain teachers must have a stronger academic background of specific subject matter knowledge. They have emphasized the perceived problem of poor academic preparation of teachers by citing declining SAT scores, an unacceptable high school student performance and drop-out rate, and millions of illiterate adults. (College Board 1984, Hahn 1987, Hirsch 1987, Ravitch, Finn 1987.) Experts in the field of mathematics conclude that students have failed to acquire the skills or understanding of mathematics which will enable them to "participate effectively in the cultural, economic, political and scientific environments of the future" (Campbell, Fey, 1988 p. 53).

Teacher education programs offer coursework concentrations in general or specific subjects to prospective teachers. The depth and consistency of program offerings and curricula continues for there appears to be limited common substance to education program curricula. (Holmes 1986, Conant, 1963)

Lee Shulman maintains that specific subject matter knowledge possessed by teachers has not been studied in depth. For Shulman, "it remains unclear what teachers know about their specific subject matter" (1987 p. 108).

The present study approached the topic of teacher preparation by asking elementary, middle and high school teachers assigned the responsibility of teaching mathematics, to identify from which learning environment specific concept and procedural knowledge within the discipline of mathematics of was first learned and apprehended .

A survey instrument was sent to school districts throughout Oregon and to selected districts in California where they were identified on the basis of student population size. After receiving authorization from district and building administrators, within each district elementary, middle and high school teachers of mathematics were asked to participate in the survey.

A descriptive format was used to summarize the relationship between the Essential Learning Skills of Oregon and the educational content knowledge preparation of teachers.

FINDINGS

Based on the analysis of data obtained from the questionnaire the following conclusions have been drawn:

1. Examination of the data strongly indicated that little or no relationship exists between teachers' concept and procedural knowledge of the Essential Learning Skills of Oregon and their preparation as teachers. Comparisons of numerical totals provided by teachers on the instrument identified that 2 out of 3 teachers apprehended their knowledge in a K-12 learning environment. Data bear out this relationship by a ratio of approximately two to one.
2. It was determined that no relationship exists between teachers' degrees and their teaching assignment relative to mathematics instruction at the elementary and high school levels. At the

middle school level a relationship does exist measured by elementary standards.

A second analysis at the middle school level using secondary standards determined no relationship existed.

a. Of 25 teachers at the elementary level responding to demographic items, none had majored or minored in mathematics. Further analysis showed that a total of 12 content courses, 27 mathematics education courses, and 11 inservice activities were completed by these teachers. This is approximately 1.5 courses per teacher.

b. A review of 42 middle school teacher responses to demographic items revealed 11 majors and six minors in mathematics. In addition, 13 majored or minored in related fields of science and computers for a total of 29 teachers (69%) with a background in mathematics.

Analysis of teacher responses at the middle level showed that teachers completed more than 6.6 college level courses in mathematics per teacher as compared with OSU requirements of 4 for a degree in elementary education.

A second analysis of teacher responses at the middle level showed that teachers completed more than 6.6 college level courses in mathematics per teacher as compared with OSU requirements of 19 for a degree in secondary mathematics.

c. A review of 36 high school teacher responses to demographic items revealed 15 majors and 12 minors in mathematics. In addition, 8 teachers majored or minored in related fields of science or computers.

An analysis of teacher responses at the high school level revealed that teachers completed more than 11.4 college level courses in mathematics per teacher as compared with OSU requirements of 19 for a degree in secondary mathematics.

Of the requisite coursework for majors in mathematics, only 60% of the high school sample of 36 teachers fulfilled the established requirements.

3. No relationship was found between teachers who graduated from Oregon institutions of higher education and their content knowledge of the Essential Learning Skills of Oregon.

Of the 99 teacher respondents from Oregon 28%, graduated from institutions of higher education outside of Oregon.

Teachers indicated by survey responses that their knowledge of the mathematics concepts contained in the Essential Learning Skills was acquired in a K-12 (PE, 44%) and teacher (TE, 15%) experience.

4. No relationship was found between teachers who graduated from institutions of higher education outside Oregon and their content knowledge of the Essential Learning Skills of Oregon. Teachers indicated by their survey responses that their knowledge of the mathematics concepts contained in the Essential Learning Skills was acquired in a K-12 (PE, 54%) and teacher (TE, 20%) experience.

CONCLUSIONS

Data collected from participant responses led to the following conclusions:

Overall, teachers believe they have conceptual and procedural knowledge of the mathematics concepts contained in the Essential Learning Skills of Oregon. Less than 23% say they learned and apprehended the knowledge from an undergraduate or graduate experience.

Teachers assigned to teach mathematics at the elementary and high school levels have not met OSU degree requirements for a bachelors of arts in mathematics education for their respective levels.

Teachers assigned to teach mathematics at the middle school level have met OSU mathematics coursework requirements for a bachelors of arts in elementary education.

Teachers believe that they did not first apprehend content knowledge of the Essential Learning Skills in undergraduate and graduate programs within Oregon.

Teachers believe that they did not first apprehend content knowledge of the Essential Learning Skills in an undergraduate or graduate program within their respective state institution of higher learning.

IMPLICATIONS

One concern of educational reformists such as the Holmes Group is the intellectual preparation of teachers. Shulman and his researchers are concerned with the many methods utilized to measure teachers' subject matter content knowledge. Hashweb maintains a teacher's subject matter knowledge contributes significantly to the transformation of written curriculum into enactive curriculum. Leinhardt found that expert teachers are better able to plan and develop more appropriate mental representations during lesson pre-planning and instruction. With these concerns in mind this study found:

1. That most elementary teachers have not met the minimum 12 hours mathematics course requirements as part of a bachelors degree in elementary education at Oregon State University.
2. That middle school teachers exceed the minimum 12 hours mathematics course requirement as part of a bachelors degree in elementary education at Oregon State University.
   Further analysis of teacher responses revealed that teachers completed only 6.6 college courses in mathematics per teacher out of a required 19 for the bachelors degree in secondary education.
3. That only 42% of the high school teacher respondents have met the 12 course minimum requirement for mathematics majors for a bachelors degree in secondary education at Oregon State University.
4. That no significant difference exists between the mathematics preparation of teachers trained in Oregon and those trained in other states and the teachers' knowledge of the Essential Learning Skills of Oregon.
5. That 50% of the teachers sampled are academically minimally prepared in mathematics

subject matter content knowledge.

6. Teachers participating in sample who are academically minimally prepared would not be considered experts in the field of mathematics.
7. Teachers participating in sample who are academically minimally prepared would be less able to contribute significantly to the transformation of written curriculum into enactive curriculum.
8. Teachers participating in sample who are minimally prepared would not be able to plan and develop more appropriate mental representations during lesson pre-planning and instruction.

The previously discussed implications were born from the data gathered and resultantly leave this researcher more concerned than ever about the quality of education we provide young people.

In 1986 the report, "A Nation Prepared: Teachers for the 21st Century", changed the focus of school reform from trying to improve school sites to improving the preparation and performance of teachers. I believe the data in this study vividly identifies the need to return the focus of attention to improving school sites. This new attention would be in the form of how teacher knowledge is being utilized on a day by day, term by term, year by year basis within the school setting.

Relationship patterns within individual district tables reveal many new questions to be resolved concerning the content knowledge of the respondents and how this knowledge is being utilized. Proper utilization of teacher content knowledge is a key factor to quality education. A table by table review reveals that:

DISTRICT A

1. Four out of eight elementary teachers have degrees in elementary education.
2. None of the eight have a degree in mathematics.
3. Four out of the eight have certification to teach mathematics.
4. 94% of the mathematics courses taken by the eight elementary teachers were special math education courses.
5. Only 12% of the courses completed by middle school teachers were senior level courses in mathematics.
6. Only 8% of the courses completed by middle school teachers were special math education courses.
7. Strand 6, statistics and probability, is the only strand identified where the greatest percentage (35%) of content knowledge was gained through teaching experience.

DISTRICT B

1. Eight out of the 13 respondents graduated from collegies/universities outside Oregon.
2. Middle school teachers were better prepared in mathematics than in other districts surveyed.
3. All elementary teachers were certified to teach math.
4. Middle school teachers completed more courses than District A.
5. Strand 6, statistics and probability, is the only strand identified where the greatest percentage (35%) of content knowledge was gained through undergraduate courses.

DISTRICT C

1. Elementary responses revealed almost no background in mathematics.
2. Middle school responses revealed very few math majors but quite a number of courses completed in math content.
3. Middle school teachers have been assigned to teach math only 78% of their teaching career.
4. Strand 6, statistics and probability, is the only strand identified where the greatest percentage (46%) of content knowledge was gained through undergraduate courses.
5. 65% of respondents' content knowledge was acquired at the prior experience level. This is considerably higher than the other districts.

DISTRICT D

1. Elementary and middle school responses revealed no math majors.
2. There was only one math major at the high school level.
3. Only 5% of the courses completed by middle school teachers were senior level courses in mathematics.
4. Half of the courses completed by elementary school teachers were special math education courses.
5. Strand 3, problem solving skills and strategies to solve routine and non-routine problems, identified a greater percentage (55%) of content knowledge was gained through teaching experience.
6. 26% of the courses completed by high school teachers were senior level courses in mathematics.

DISTRICT E

1. Middle school responses revealed no math majors.
2. Only 33% of the middle school teachers were certified to teach mathematics.
3. Middle school teachers have been assigned to teach math only 72% of their teaching career.

4. Strand 3, problem solving skills and strategies to solve routine and non-routine problems, identified a greater percentage (54%) of content knowledge was gained through teaching experience.
5. Strand 6, statistics and probability, as identified by respondents, revealed a greater percentage (32%) of content knowledge was gained through teaching experience.

RECOMMENDATIONS

1. Replicate this study in other subject matter content areas to determine if a relationship exists between subject area and the Essential Learning Skills of Oregon.
2. Replicate this study using only OSU graduates with elementary or secondary education degrees over the past 10 to 15 years and compare results with this study.
3. Conduct studies using methodology from Shulman's, Hashweb's and/or Leinhardt's studies, on a sample of teachers at the elementary, middle and high school levels to determine whether teachers assigned outside their major

area who are academically minimally prepared in subject matter content, may be classified as experts within the teaching area assigned.

4. Consideration should be given to the development of standards in mathematics degree programs and state certification for middle school teachers.
5. Conduct a study to determine the individual's depth of understanding of the Essential Learning Skills by teachers who indicated they acquired them in a K-12 (PE) vs the teachers who acquired them in an undergraduate (U), or graduate (G) experience.

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APPENDICES

APPENDIX A

LETTER INTRODUCING INSTRUMENT AND RESEARCH TOPIC

Teachers of Math Survey

The Relationship of Teachers' Mathematic Preparation and Degree Level to Essential Learning Skills.

The objective of this study is to identify the specific content knowledge taught in the mathematics curriculum of undergraduate or graduate programs of selected colleges and universities with four, five or fifth year teacher education programs. The focus of this study is to compare the content knowledge within these programs to identify the most appropriate means of preparation for elementary, middle and high school teachers, particularly as it pertains to their teaching within the parameters of the Essential Learning Skills of Oregon.

The nine categories on the survey tool have been gleaned from the Comprehensive Curriculum Goals in Mathematics for the State of Oregon 1987. To simplify the tool, only grades 5, 8 and 11 have been used so as to align with the elementary, middle and high school subject matter areas.

To assist in the completion of the survey, you are asked to identify in which environment each concept or procedural knowledge was first learned and apprehended by circling the descriptor(s) of your choice.

PE = Prior Education (K-12)
U = Undergraduate
G = Graduate
TE = Teaching Experience
N = No knowledge of

For your interest, copies of the survey results will be provided to participating districts after summary completion.

I want to thank you for your assistance in providing valuable input to this research project. Your time and effort are appreciated.

Sincerely,

Gerald M. Balaban
422 Education Hall
Oregon State University
Corvallis, Oregon 97331

APPENDIX B

SURVEY DEMOGRAPHICS

TEACHERS OF MATH SURVEY

Please fill in appropriate response:

College/University(s):

----------------------	Degree ______	Major ___________	Minor ___________

Teaching Assignment: (identify preps)

Grad. Degree_________ Other___________

Number of years teaching ______________

Number of years teaching math ______________

Please check the appropriate level:

Certification:

Elem. ____________

____

Sec. ____________

____

Level(s) of math you teach:

Elem. K-5___;Middle 6-8___;High Sch___

Basic math______ Interm. Math_____

Advanced Math____ Algebra_________

Geometry_________ Trigonometry_____

Calculus_________

Math Courses taken during college: (put a check next to the course(s) taken)

100 Beginning Algebra ___
Intermediate Algebra ___
Advanced Algebra ___
College Algebra ___
Calculus ___
200 Differential Calculus ___
Integral Calculus ___
Series and Vector Calculus ___
Linear Equations and matrices ___
300 Vector Calculus ___
Applied Differential Equations___
Geometry ___
Linear Algebra ___
Theory of Numbers ___
Logic ___
Intro. to Probability] ___
400 Metric Spaces in Analysis ___
Complex Functions ___
Variational Problems ___
Differential Geometry ___
Abstract Algebra ___
Theory of Probability ___

Other:
Math Content Inservice ___

Special Courses in Math Education:

100 Arith. as a Logical Structure___
Informal Geometry ___
Elementary Mathematics ___
300 Problem Solving for Teachers ___
Intro. to Probability ___
Intro. to Modern Algebra ___
400 Foundations of Arithmetic ___
Found. of Algebra ___
Found. of Geometry ___
Numerical Analysis ___

Other:
Math Methods Inservice ___

APPENDIX C

SURVEY INTRUMENT

Please identify in which environment each concept or procedural knowledge was first learned and apprehended by circling the appropriate descriptor(s) of your choice.

PE = Prior Education (K-12)
U = Undergraduate
G = Graduate
TE = Teaching Experience
N = No knowledge of

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1. Number and numeration concepts used to read, write, order, compare and use numbers.

a. Identify the number of ones, tens, hundreds, thousands, ten-thousands and hundred-thousands in numbers less than one million, and tenths, hundredths, thousandths in numbers less than one. PE U G TE N

b. Order, compare and model commonly used fractions, decimals, percents and signed numbers, and give examples of positive and negative quantities (e.g., temperature, bank balance). PE U G TE N

c. Use numeration concepts, number properties and apply order of operations rules as appropriate for mental, paper/pencil and calculator usage. PE U G TE N

2. Appropriate computation skills with manipulatives; mental (in the head), paper/pencil estimation or calculator usage.

a. Select and use the most appropriate tool of computation (manipulative, mental, estimation, paper/pencil, calculator) in a given situation involving whole numbers or commonly used fractions. PE U G TE N

b. Use paper/pencil to perform: addition, subtraction, multiplication and 1-digit division of whole numbers; addition and subtraction of decimals; addition and subtraction of fractions with like denominators. PE U G TE N

c. Use rounding and other techniques useful in mental computation to estimate and make appropriate whole number, fraction, decimal and percent computations. PE U G TE N

d. Compute using measures. PE U G TE N

e. Use and apply estimation techniques.	PE	U	G	TE	N
f. Use concrete materials or "real world" examples to demonstrate operations with whole numbers, fractions, decimals and percents.	PE	U	G	TE	N

3. <u>Problem solving skills and strategies to solve routine and nonroutine problems.</u>

a. Solve problems using a variety of strategies such as guessing and checking, making predictions based upon a pattern, making a drawing or model.	PE	U	G	TE	N
b. Solve problems using appropriate strategies such as making a systematic list, looking for patterns, eliminating possible answers, or solving a simpler problem.	PE	U	G	TE	N
c. Identify, conceive or create problems that can be solved by using ratio and proportion; and use proportion to solve problems.	PE	U	G	TE	N
d. Identify problems, pose problems; select gather, organize, analyze appropriate information for solving problems.	PE	U	G	TE	N
e. Design and carry out a plan for solving a problem.	PE	U	G	TE	N

4. <u>Geometric concepts and relationships.</u>

a. Identify properties of common geometric figures, including quadrilaterals and geometric solids.	PE	U	G	TE	N
b. Sketch or build common geometric solids and two-dimensional figures.	PE	U	G	TE	N
c. Estimate and determine perimeter, area, and volume of common geometic figures by means other than formula.	PE	U	G	TE	N
d. Draw the net (2 dimensional pattern) for common geometric solids, e.g., cube, rectangular prism, cylinder.	PE	U	G	TE	N

e. Identify and compare common two- and

three-dimensional geometric shapes and solids according to attributes and properties.	PE	U	G	TE	N
f. Use a formula for finding perimeter area and volume of common geometric figures.	PE	U	G	TE	N
g. Apply and use circle and common right triangle relationships in solving problems.	PE	U	G	TE	N
h. Use protractor, compass, ruler, computer and other instruments to make common geometric constructions.	PE	U	G	TE	N

5. <u>Measurements to keep records, solve problems and make predictions.</u>

a. Recognize and use commonly used metric and English units, and select the appropriate instrument and unit for a measurement task.	PE	U	G	TE	N
b. Estimate and determine the weight (mass) of common classroom objects in metric and English units.	PE	U	G	TE	N
c. Make scale drawings and determine actual distances from scale drawings, blueprints, maps and globes.	PE	U	G	TE	N
d. Measure by some direct means the area of a polygon or some 2-D region with curves as boundaries, and the volume of 3-D objects.	PE	U	G	TE	N

6. <u>Statistics and probability; collect, organize, record and interpret data.</u>

a. Read, interpret, construct bar graphs, line graphs, tables and charts, and make predictions based upon them.	PE	U	G	TE	N
b. Organize information into tables/charts and diagrams with appropriate scale including box plots, box and whiskers, line plots.	PE	U	G	TE	N
c. Follow directions to conduct probability experiment and identify possible hypotheses from observed data used.	PE	U	G	TE	N

d. Identify and demonstrate situations in which probability or chance of an event occurring is likely, unlikely, equally likely; and whether a game is "fair." PE U G TE N

e. Use data gathering procedures which will aid in answering questions of interest (conducting polls, sampling schemes). PE U G TE N

f. Identify misleading or incorrect methods of displaying or interpreting data. PE U G TE N

g. Determine, interpret and compare advantages and disadvantages of mean, median and mode. PE U G TE N

h. Organize and display data using tables, charts, graphs and diagrams. PE U G TE N

i. Understand the relationship between size of sample and degree of certainty. PE U G TE N

j. Develop a hypothesis using data from a variety of sources. PE U G TE N

7. <u>Mathematical relationships and logical thinking.</u>

a. Classify objects and simple geometrical figures by attributes. PE U G TE N

b. State relationships using terms such as "greater than," "less than," and "equal to" and use the symbols >,<, =. PE U G TE N

c. Find numerical patterns in 100-charts and addition and multiplication tables (e.g., odd/even, primes), and use patterns to complete simple charts and tables, and make predictions. PE U G TE N

d. Organize information or data using formats such as outlining, making maps, tables, charts, graphs; and computer spread sheets. PE U G TE N

e. Show, using models such as 100-grids, number lines or a meter stick, how percent can be expressed as a fraction or decimal, and conversely. PE U G TE N

f. Infer direct and indirect cause and effect relationships. PE U G TE N

g. Interpret and use the concepts of ratio, percent, proportion and commonly occurring rates such as growth, speed, interest and cost per unit.	PE	U	G	TE	N
h. Present arguments using deductive or inductive reasoning for a particular purpose.	PE	U	G	TE	N

8. <u>Oral and written communication of mathematical concepts.</u>

a. Ask questions designed to clarify, gain assistance, or locate information.	PE	U	G	TE	N
b. Take notes and prepare summaries based on oral presentations and group discussions.	PE	U	G	TE	N
c. Use writing appropriate to purpose such as to inform, pose problems, or solve problems.	PE	U	G	TE	N
d. Write complete sentences.	PE	U	G	TE	N
e. Use dictionaries, glossaries and other reference materials to find word meanings.	PE	U	G	TE	N
f. Use basic mathematical terms and symbols to convey concepts of quantity, order, operation and shape in oral or written form.	PE	U	G	TE	N
g. Separate between relevant and irrelevant information used to draw conclusions.	PE	U	G	TE	N
h. Produce legible final copy using manual or electronic processes.	PE	U	G	TE	N
i. Share ideas and information orally with others, including cooperative learning and problem solving situations.	PE	U	G	TE	N
j. Argue opposite sides of issues.	PE	U	G	TE	N
k. Write multi-paragraph personal journals, reports or problem solution strategies.	PE	U	G	TE	U

9. <u>Appropriate study skills to accomplish mathematical learning.</u>

a. Keep study materials organized and accessible.	PE	U	G	TE	N
b. Turn in assignments on time.	PE	U	G	TE	N

c. Accomplish learning tasks using appropriate study techniques such as preview and review, read and re-read, ask clarifying questions, seek help when needed, use memory techniques, summarize, study with classmates, use self-questioning.	PE	U	G	TE	N
d. Determine general purpose of assignment and ask for clarification if necessary.	PE	U	G	TE	N
e. Use library classification system (including computerized) and services to locate specialized resources required to complete assignments.	PE	U	G	TE	N
f. Edit to produce a correct legible, effective piece of writing (manual or electronic).	PE	U	G	TE	N
g. Spell correctly.	PE	U	G	TE	N
h. Revise own writing to correctiveness and comprehensiveness.	PE	U	G	TE	N
i. Use descriptive and connecting terms to enhance meaning, clarity and precision.	PE	U	G	TE	N

Please feel free to make any comments concerning survey topic.

APPENDIX D

LETTER TO DELPHI PANAL

April 18, 1989

Dear

Enclosed is a copy of the survey tool I propose to use as the bases of my doctoral dissertation. The objective of this study is to identify the specific content knowledge taught in the mathematics curriculums of undergraduate or graduate programs of selected colleges and universities with four, five or fifth year teacher education programs. The focus of this study is to compare the content knowledge within these programs to identify the most appropriate means of preparation for elementary, middle and high school teachers, particularly as it pertains to their teaching within the parameters of the Essential Learning Skills of Oregon.

Your present participation is to review the survey tool and identify any ambiguities or shortcomings. I ask that you react to each item according to the following scale:

Retain____(Place a check mark next to the left of the item)
Reject____(Put a X through the item)
Modify____(change question to lend greater specificity or clarity)

If you have any questions please do not hesitate to call me at OSU, 503-754-3648.

I want to thank you for your assistance and hope that my project does not take too much of your time.

Sincerely,

Gerald M. Balaban
School of Education
OSU/WOSC
Oregon State University
Corvallis, Oregon 97331

APPENDIX E

DELPHI PANEL MEMBERS

DELPHI PANEL MEMBERS

Name	Address	Position
Dianne Erickson	Oregon State University Corvallis, Oregon	Asst. Professor
Joe Hoffman	California State Dept of Education PO Box 944272 Sacramento, Ca	Director of Curriculum
Gene Maier	Portland State University Portland, Oregon	Assoc. Professor
Ron Morgali	Western Oregon State College Monmouth, Oregon	Assoc. Professor
Howard Wilson	Oregon State University Corvallis, Oregon	Professor