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A Model Geometry and Probability Supplemental Curriculum for Fourth Grade Students in Alignment with the Washington State Essential Academic Learning Requirements for Mirror Lake Elementary School, Federal Way School District, Federal Way, Washington

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A MODEL GEOMETRY AND PROBABILITY SUPPLEMENTAL CURRICULUM FOR FOURTH GRADE STUDENTS IN ALIGNMENT WITH THE WASHINGTON STATE ESSENTAIL ACADEMIC LEARNING REQUIREMENTS

FOR MIRROR LAKE LEMENTARY SCHOOL,

FEDERAL WAY SCHOOL DISTRICT

FEDERAL WAY, WASHINGTON

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By

Melanie Jane Strey

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A Model Geometry and Probability Supplementary Curriculum Unit for

Mirror Lake Elementary School in the Federal Way School District,

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The purpose of this project was to develop and implement a model supplemental geometry and probability curriculum for Mirror Lake Elementary in the Federal Way School District, Federal Way, Washington. To accomplish this purpose, a review of related literature was conducted. Additionally, related information and materials from selected sources was obtained and analyzed. Control Groups were formed to test district provided curriculum and district provided curriculum with supplemental units. The results showed greater student academic gains when the district provided curriculum was supplemented with additional material.

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CHAPTER ONE
BACKGROUND OF THE PROJECT

"One goal of teachers of young children, then, should be to tap into those experiences and link the learning of mathematical concepts to contexts that are meaningful to children" (Raymond, 1995, p. 172).

Introduction

Mathematics is a vital element to many areas of life. Mathematics is more than simple facts and expressions. It is the foundation to logical thinking and problem solving. Moving beyond basic memorization and developing an in depth understanding of mathematical concepts, typically means moving beyond the textbook. This curriculum project focused on designing and adapting supplemental geometry and probability units. Many students need concrete, sequential basics, as well as authentic-rich experiences involving the use of math manipulatives and games.

Essentially, the ability to understand mathematics, in a real-life context, is the goal for each student. Raymond (1995) stated, "children's thinking will support their successful use of mathematics in solving real-world problems" (p.18). The Washington State Commission on Student Learning has supported conceptual learning through the development of the State Essential Academic Learning Requirements (EALR's) extensively in the area of mathematics. This project combined school-based text and supplemental units in alignment with the fourth grade Washington State academic expectations.

Purpose of the Project

This project is a supplemental mathematics program for a fourth grade classroom. Utilizing the EALR's in geometry and probability, students interacted with hands-on mathematical experiences. The author constructed two supplemental units equipped with teacher lesson plans, which include; day-by-day instructions, materials and resources needed, and state EALR's.

Significance of the Project

The attention given to understanding mathematical concepts was of great concern in the Federal Way School District. The district encouraged all elementary buildings to analyze Washington Assessment of Student Learning (WASL) scores and the district provided grade level tests to determine areas of weakness. The data indicated that the author and fellow teachers' student population showed signs of weaknesses in the mathematical areas of geometry and probability. Pickreign (2000) noted concerns about school geometry are "derived from two major problems: poor performance of students and an outdated curriculum" (p. 243). Likewise, the need for the project supported Pickreign's concerns.

The author's project provided grade three and four teachers with meaningful, effective supplemental geometry and probability units that align with state expectations.

Limitations of the Project

The geometry and probability supplemental mathematics units are designed primarily for students in grade four, although adaptations can be made to the lesson plans for one grade level below or above. The supplemental units, by themselves, will not necessarily produce growth in other mathematical areas. The units are designed to supplement textbooks that lack authentic materials in the area of geometry and probability.

The research summarized in Chapter Two was limited primarily to research current within the last ten years.

Definition of Terms

WASL: Washington Assessment of Student Learning: The Commission on Student Learning developed an assessment system that holds students, teachers, schools, and districts accountable for better performance and results. The state-level WASL assessments require students to both select and create answers to demonstrate their knowledge, skills, and understanding in each of the Essential Academic Learning Requirements (EALR's)--from multiple-choice and short-answer questions to more extended responses, essays, and problem solving tasks. (OSPI, November 2001)

ITBS: Iowa Test of Basic Skills: Students in Grades 3 and 6 were tested with the Iowa Tests of Basic Skills (ITBS) and in Grade 9 with the Iowa Tests of Education Development (ITED). The tests required students to read critically and with understanding, to compute with accuracy, to solve mathematical problems, and to demonstrate their knowledge of important ideas, principles and procedures (OSPI, November, 2001).

Essential Academic Learning Requirements: statewide academic standards have been developed for the "basics"--reading, writing, communication, and mathematics, and for science, history, geography, civics, economics, arts, and health & fitness. They represent the specific academic skills and knowledge students will be required to meet in the classroom (OSPI, November, 2001).

NCTM: National Council for Teachers of Mathematics: As the primary professional organization for teachers of mathematics in grades K–12, the National Council of Teachers of Mathematics (NCTM) has the responsibility to provide broad national leadership in matters related to mathematics education (NCTM, November, 2001).

Overview of the Remainder of the Project

Chapter Two summarizes relevant literature pertaining to math reform and current teaching practices. Chapter Two is organized to address Washington State's mathematics reform and state standards, followed by literature pertaining to textbook instruction, math manipulatives, and concluding with Marilyn Burns' instructional model. Chapter Three describes and summarizes background information, which includes; the need for the project, development to support the study, support materials acquired, and project implementation planned. Chapter Four describes the initial stage of the project with specific data and curriculum concerns at the district and school level. Chapter Four then summarizes the geometry and probability supplemental units used by the author's control groups. Chapter Five summarizes the project history and assessment results. Conclusions are cited and future recommendations are made regarding areas, which may be further studied in the area of supplemental mathematic units and project implementation.

CHAPTER TWO

A REVIEW OF RELATED LITERATURE AND INFORMATION OBTAINED FROM SELECTED SOURCES

Introduction

The review of research, literature, and information summarized in Chapter 2 has been organized to address:

1. Washington State Essential Academic Learning Requirements
2. Math Reform
3. Essential Academic Learning Requirements for Grade Four Students: Geometry and Probability
4. Traditional Textbook Instruction
5. Effective Curriculum Using Math Manipulatives
6. Marilyn Burns' Instructional Model

Education Reform

In 1993, Washington State public school educational system set out to improve student learning and raise state student achievement. The state legislature created the Commission on Student Learning referred to in this text as the Commission. The Commission of Student Learning was committed to developing performance-based assessment that align curriculum with benchmark expectations.

The commission was charged with three important tasks in support of public school change:

1. To establish Essential Academic Learning Requirements (EALR's) that describe what all students should know and perform in eight content areas: reading, writing, communication, mathematics, science health/fitness, social studies, and the arts;
2. To develop an assessment system to measure student progress at three grade levels toward achieving the EALR's;
3. To recommend an accountability system that recognizes and rewards successful schools and provides support and assistance to less successful schools (Lake Washington, 2001).

By 1995, the Commission had achieved its first major task by implementing EALR's in reading, writing, communication, and mathematics. In 1997, revisions were made and benchmarks for grade four, grade seven, and grade ten were in place. Academic benchmarks require assessment tools. The Lake Washington School web site described assessment in regards to four major components: state-level assessment, classroom-based assessments, professional staff development, and school and system context indicators (Lake Washington, 2001). The Washington Assessment of Student Learning (WASL) is a state test designed to test students with questions that align with grade equivalent benchmarks. Classroom teachers and curriculum specialists created the assessments in reading, communication, and mathematics. Internal committees were formed to monitor and control assessment validity and reliability.

In addition to a state level test, the Commission strongly encouraged schools to implement assessment tools, similar to the state's model. The premise was if teachers use the EALR's to guide teaching instruction, then classroom assessments should be administered in the same way materials were presented. The Lake Washington school district website summarizes the Commission's intentions;

1. Classroom based assessment helps students and teachers better understand the EALR's and to recognize the characteristics of quality work that define good performance for each content area.
2. Classroom based assessment provides coverage of some of the EALR's for which state-level assessment is not feasible.
3. Classroom based assessment offers teachers and students opportunities to gather evidence of student achievement in ways that best fit the needs and interests of individual students.
4. Classroom based assessment helps teachers become more effective in gathering valid evidence of student learning related to the EALR's.
5. Classroom based assessment can be more sensitive to the developmental needs of students and provide the flexibility necessary to better accommodate the learning styles of children with special needs (Lake Washington, 2001).

A classroom based assessment "Tool Kit" has been developed to provide teachers with examples of assessment strategies. The kit includes models for paper and pencil tasks, generic checklists for skills and traits, observation assessment strategies, simple rating scales, and generic protocols for oral communication.

Mathematics Reform

The Office of the Superintendent of Public Instruction (OSPI) stated "mathematics continues to grow at a rapid rate, spreading into new fields and creating new applications, in its open-ended search for patterns" (OSPI, 2001, p.1).

Dr. Terry Bergeson stated on the OSPI curriculum and instruction website the following message;

> "All students must develop and sharpen their skills, deepen their understanding of mathematical concepts and processes, and hone their problem solving, reasoning, and communication abilities while using mathematics to make sense of, and to solve, compelling problems. All students need a deeper understanding of mathematics; for this to occur, rigorous mathematical content must be reorganized, taught, and assessed in a problem-solving environment. For students to develop this deeper level of understanding, their knowledge must be connected to a variety of ideas and skills across topic areas and grade levels in mathematics, to other subjects taught in school, as well as situations outside of the classroom" (OSPI, 2001, p. 1-2).

The first EALR requires the student understand and apply concepts and procedures in the following math areas: number sense, measurement, geometric sense, algebraic sense, and probability and statistics. Secondly, the student must use mathematics to clearly define and solve problems. Through investigating, exploring, formulating questions, and constructing solutions, each student gains mathematical problem solving strategies. Next, each student needs to develop sound mathematical reasoning. To accomplish this skill, the student begins to analyze information, predict results, make inferences based on his/her analysis, and draw conclusions based on results. The fourth area suggests the student must clearly communicate his/her knowledge and understanding using mathematical language. To acquire this communication skill it is vital that each student gathers information, organizes and interprets that information, and represent understanding of the information using terms, language charts, and graphs. Finally, each student must understand how mathematical ideas connect within mathematics, to other subject areas, and to real-life situations (OSPI, 2001, p. 2-4).

The five indicators of educational understanding are meant to give an overview of the Commission's intent. Each math strand has grade level equivalent objectives. The Commission's intent is that mathematics at each grade level become cohesive and consistent.

The following section defines the EALR's for grade four in geometry and probability. With the above overview of the state objectives, it is important for the purpose of this study, to focus on grade level specific geometry and probability goals and objectives. In addition to understanding and applying geometric concepts and procedures, students must demonstrate the following learning objectives:

- use attributes and properties of parallel and perpendicular to identify, name, compare, and sort geometric shapes and figures
- recognize geometric shapes in surrounding environment, for example, identify rectangles within windows
- understand concepts of symmetry, congruence, and similarity
- draw and build simple shapes and figures using the appropriate tools, such as a straightedge, ruler, protractor, or nets
- describe the location of objects relative to each other on maps or coordinate grids in the first quadrant

- understand and draw simple geometric transformations using translations (slides), reflections (flips), or rotations (turns)

In addition to understanding and applying probability and statistics, students must demonstrate the following learning objectives: (OSPI, 2001, p. 7-8)

- understand the difference between certain and uncertain events
- know how to list all possible outcomes of simple experiments
- understand and use experiments to investigate uncertain events
- predict outcomes of simple activities and compare predictions to experimental results
- understand and make inferences based on experimental results using coins, numbers cubes, spinners, etc.

OSPI stated, that Washington State has never had common goals for which students and educators were accountable. Earlier attempts to set standards had districts developing checklists. No statewide coherent attempt to measure achievement was in place until the EALR's. The EALR's represented the specific required academic skills and knowledge needed to provide state cohesiveness. The EALR's targeted content specific and grade equivalent benchmarks for principals, teachers and students across the state (OSPI, 2002). Dr. Jerry Johnson, author of <u>Teaching and Learning Mathematics,</u> stated that the student's role and actions depend primarily on the view of mathematics projected by the teacher. Studies of the culture of mathematics in classrooms show the linearity and formality associated with most teaching from published mathematic schemes or textbooks. Such textbooks tend to produce a passive acceptance of mathematics in the abstract, with little connection being made by pupils between work and real life. Pupils see mathematics in a right or wrong nature, as well as the quantity and correctness of mathematic completion. When beliefs about mathematics are socially constructed knowledge, pupils take on a different role. Pupils are expected to contribute his/her own ideas, try his/her own solutions, and challenge the teacher (p. 52).

Traditional Textbook Instruction

Generally, elementary textbooks have only a small section in the areas of geometry and probability. The Washington Assessment of Student Learning requires students demonstrate knowledge of geometry and probability. This presents a concern not only for teachers in Washington State, but also teachers in the United States. Pickreign (2000) discussed that the area of geometry continues to be an important issue in mathematic education addressed by the (NCTM) National Council of Teachers of Mathematics and the (NCEE) National Center of Education and the Economy (p. 243). Pickreign's study demonstrated "that there is a substantial misalignment between the geometry presented in textbooks, the geometry expected to be taught by groups such as NCTM, and the geometry being assessed in student performance measures as suggested by the NCEE" (p. 243).

Pickreign stated that textbook places the bulk of geometry-related chapters in the latter half of the book and latter chapters are rarely covered at any great depth or even at all (p. 243). As Vann stated, "on the recommendation of a committee of teachers," textbooks that were purchased "focus on real-world problem solving, de-emphasize rote computation and drills, include good sections of probability, statistics, estimation, mental math, and geometry" (p. 39).

Vann (1995) found, in a study of teachers, that four months into the year with "better" textbooks, the same math was being provided in "the same old way in many classrooms-excessive fact drills and practice worksheets, more time spent on algorithms than on problem solving, rare use of student calculators, and most manipulatives and overheads gathered dust" (p. 40). Johnson (2000) stated that the depth of the mathematics taught correlates highly with the depth of the teachers' mathematical knowledge. Furthermore, Johnson maintained that student's engagement at higher levels requires the teacher to select appropriate tasks for the students, support proactively the students activity, ask students consistently to provide meaningful explanations of student work and reasoning, push students consistently to make meaningful connections, and to not reduce the complexity/cognitive demands of the task (p. 53). Vann stated, that although many school districts have begun reforming district mathematics curriculum and textbooks, it is far more difficult to change the "how" of teaching. Vann's study found that although teachers were given new curriculum, new materials may remain unused if lessons require significant changes in teaching techniques. Johnson referred to a study conducted in 1989 by Sowell. In Sowell's analysis of 60 studies, long-term use of concrete instructional materials and the students' attitudes toward mathematics are improved when students have instruction with concrete materials provided by teachers knowledgeable about material use (p. 40).

Effective Curriculum Using Math Manipulatives

Bovalino and Stein (2001) stated, "Manipulatives can be important tools in helping students to think and reason in more meaningful ways. By giving students concrete ways to compare and operate on quantities, such manipulatives as pattern blocks, tiles, and cubes can contribute to the development of well-grounded, interconnected understandings of math" (p. 356). Manipulatives by themselves are not instructional strategies, rather one piece of the puzzle. As Vann addressed earlier, textbooks typically focus more on mathematical drills and algorithms. Manipulatives offer teachers another tool for helping students develop a deep mathematical understanding, especially in math strands such as geometry and probability.

Geometry is an area that the NCTM (2001) stated in the Principles and Standards for School Mathematics that students should "develop knowledge about how geometric shapes are related to one another and begin to articulate geometric arguments about the properties of these shapes" (p. 2). Furthermore, NCTM stated that students must build and sort information, as well as, visualize relationships developed. In conjunction, students need to "reason and to make, test, and justify conjectures about these relationships. This exploration requires access to a variety of tools, such as graph paper, rulers, pattern blocks, geoboards, geometric solids, and electronic tools that support exploration, such as dynamic geometry software" (p.3). Fuys and Liebov discussed that, (1997) "non-examples should vary all irrelevant features. Carefully chosen non-examples help children eliminate irrelevant features and identify crucial ones" (p. 249). Students need to be provided with correct examples that show how to effectively work with geometry concepts.

Kurtz and Ross (1993) described the difficulties teachers encounter when using manipulatives. To avoid such difficulties teachers should be certain that manipulatives have been chosen to support the lesson's objectives. Prior to use, students need to be oriented on the correct use of manipulatives and classroom procedures. Lessons are designed so students have an opportunity to engage with materials. Teachers need to plan each lesson with assessment procedures that emphasize the development of mathematical reasoning (p. 256). Bovalino and Stein (2001) summarized, "manipulatives do not magically carry mathematical understanding. Rather, they provide a concrete way for students to link new, often abstract information to already solidified and personally meaningful networks of knowledge, thereby allowing students to take in the new information and give it meaning" (p. 360).

Johnson stated that there are several false assumptions about the power of manipulatives. "First, manipulatives cannot impart mathematical meaning by themselves. Second, mathematics teachers cannot assume that students make the desired interpretations from the concrete representation to the abstract idea. And third, the interpretation process that connects the manipulative to the mathematics can involve quite complex processing" (p. 40). Along with manipulatives, the key to math reform as stated by Burns is "to help children learn to think, reason, and solve problems" (Burns, 1993, p. 79). Burns, 1993, believes students' curiosity must be tapped, students' thinking must be stimulated, and they have to be actively engaged in learning and doing mathematics. "It's not okay to do anything less than that and call it education" (p. 79).

Marilyn Buns' Instructional Model

"Not too long ago, teachers saw the main goal of math instruction as helping children become proficient in paper-and-pencil computation. Today, mathematics instruction is less about teaching basic computation and more about helping students become flexible thinkers who are comfortable with all areas of mathematics and are able to apply mathematical ideas and skills to a range of problem-solving situation" (Burns, 1993, p. 28).

Making the transition from traditional mathematical instruction to a more balanced program requires a shift in the thinking of the teacher's role. Marilyn Burns, a lead teacher, instructor, and coach to teachers in the United States, strives to create a learning atmosphere for learners who have experienced mathematical stress or failure. In Burns' book, "Math-Facing an American Phobia," Burns addressed the idea that many educators still cling to the educational methods of traditional textbook learning. Burns stated, "the way we've traditionally been taught mathematics has created a recurring cycle of math phobia, generation to generation, that has been difficult to break" (p. x). Burns suggested twelve important elements to becoming a better math teacher.

The following outlines the twelve elements to a balanced mathematics program as stated by Burns in her article, "The 12 Most Important Things You Can Do to Be a Better Math Teacher" (Burns, 1993).

Step One: Do what makes sense to you.

Simply establishing roles leaves very little room for children to process the information and leaves little room for using sound reason to check for the validity of answers.

Step Two: Students need to explain his/her reasoning in all instances.

Dialogue between student and teacher is essential for evaluating whether the student is processing the information, as well as, probing the student's thought process. Given chances to explain reasoning, allows for opportunities to organize thought processes, cement and extend understanding, and explain both right and wrong answers.

Step Three: Encourage children to talk with one another during math class.

Interaction between children allows him/her to process math concepts more thoroughly. This interaction gives multiple opportunities for children to talk about his/her ideas, receive feedback, and hear other solutions and ways of thinking.

Step Four: Writing is an integral part of math learning.

Writing provides an avenue for children to revisit and reflect on steps taken towards solution. Writing also provides the teacher with an opportunity to assess student understanding. Writing in mathematics also requires pre-writing activities, such as student-to-student interaction and interdisciplinary exercises.

Step Five: Embed math activities in contexts.

Integrating real-life contexts within lessons provides students with learning opportunities. Many children's books offer a starting point for mathematical lessons.

Step Six: Use manipulative materials whenever possible.

The use of manipulative materials creates more concrete learning opportunity. Children can use materials to view mathematical ideas in many different ways. Manipulative materials can introduce concepts, pose problems, and become tools to finding solutions.

Step Seven: Bring the quality and richness often apparent in students' writing and art into his/her mathematical work.

Evidence of students work usually is presented in the form of progress charts or arithmetic worksheets, while reading and writing are displayed in an inviting atmosphere. Burns desires that mathematical lessons hone in on student creativity when thinking about math.

Step Eight: Make calculators available to all children at all times.

View calculators as a tool for enhancement. Students learn to manipulate the buttons and make sense out of the answers. A calculator can assist in tackling challenging problems students might non otherwise be able to solve.

Step Nine: Let children push the curriculum rather than having the curriculum push the children.

Teachers need to relinquish the reigns and allow depth over breadth to be the driving force. The key element to success is the student's completeness when it comes to understanding the concepts.

Step Ten: Keep an eye out for instructional activities that are accessible to students with different levels of interest and experience.

Math activities should be thought out carefully, making sure all levels of learning and engagement could take place.

Step Eleven: Remember that confusion and partial understanding are natural to the learning process.

It is important to view learning as a continuum, where the student engages in a long-range goal. Then, take into consideration the classroom climate where misconceptions are valued, yet cleared and feelings toward learning are taken into consideration.

Step Twelve: Take delight in students' thinking.

Encourage and provide opportunities for students to think in a variety of situations. Encourage participation as an assessment tool and a message to students that there are many ways to solve problems or situations.

Burns stated (1998) that, "for too long, math has been a filter that has separated students into haves and have-nots. The aim of math teaching today is for students to be either haves or have-mores" (p. 79). In summary, although product is an important element, process seems to be looked at just as seriously in the elementary years.

The EALR's in mathematics for students in Washington State, developed by the Commission on Student Learning, provide grade level benchmarks for students to achieve. The benchmarks are essential to teachers, providing teachers with a framework on which to build instructional activities. Past mathematics consisted of a steady diet of textbook problems and worksheets without consideration to mathematical relations. School mathematics was taught primarily in isolated bits and pieces (Burns, 1993, p. 67). Burns suggested, "immerse children in doing mathematics by involving them in activities, explorations, and experiments in which they use mathematics and, by so doing, learn mathematical concepts and skills. Let children learn mathematical concepts and skills in the context of thinking, reasoning, and solving problems. This process is not simply or easy. Teaching is not a simple craft. To teach math well, requires an understanding of mathematics, an appreciation of mathematics, an interest in how children learn, and the skills to be able to manage a classroom so that it invites learning" (Burns, 1993, p. 69).

CHAPTER THREE
PROCEDURES OF THE PROJECT

Introduction

The purpose of the project was to develop and implement a supplemental curriculum for grade four in geometry and probability. To accomplish this, a review of related literature was conducted. Additionally, related information and materials from selected sources were obtained and analyzed.

Chapter three contains background information describing:

1. Need for the Project
2. Development to Support the Study
3. Procedures used to Support the Study Materials
4. Planned Implementation of the Project

Need for the Project

Federal Way school district, like many school districts across Washington State, collected assessment data. This data gave a break down of each individual school's strength and weakness in each mathematics strand. Many districts have used the data to assess the overall performance of particular classes, individual students, and a pattern of strengths and weaknesses building wide. Realizing the amount of time it would take to analyze the data for each building, assess curriculum instruction for each individual classroom, and make curriculum recommendations; Federal Way created a math specialist position. Kim Prothero, mathematics specialist, has spent the past three and half years collecting data and breaking that data down, so that teachers can make adjustments and improvements to classroom instruction. In an interview, Prothero discussed her strategies for analyzing the data and formulating a plan to help teachers. Prothero began first by attending a Marilyn Burns workshop. She then offered herself as a support to teachers and building Principals. Her desire was to work with willing teachers as a support and resource, rather than an expert. Prothero felt the need to continue to study and gain more knowledge in Washington State's mathematics reform and Federal Way's current mathematical curriculum. During her first year, Prothero spent time identifying the mismatches between current curriculum and grade level state provided benchmarks.

Prothero then shared those mismatches with teachers and principals wanting to use data provided by testing to identify classroom math gaps. Prothero and teachers developed a plan for implementing a more constructivist approach to teaching. As teachers began to learn more about mathematics, the quality of teaching in mathematics lessons increased. Prothero was surprised to see that teachers taught some math lessons that didn't need to be taught and left out other mathematical strands that did need to be covered according to state benchmarks. Prothero and the author of this project spent three years working together. Constant communication consisted of mathematical conversation regarding continued curriculum realignment, additional mathematical resources, and gathered test data.

Based on Prothero's findings, it was evident that the district provided math textbook, Addison Wesley, was insufficient in the areas of geometry and probability. As a result of inadequate curriculum resources, the 1998/1999 and 1999/2000; grade four WASL school scores and grade three ITBS scores demonstrated many students in the grades four and three did not meet proficiency in the areas of geometry and probability. Linda Wilder, Mirror Lake Elementary Principal, challenged classroom teachers with a goal of increasing student learning in geometry and probability. Prothero and the author of this project concluded, that building wide the current teaching practices related to geometry and probability was inadequate for helping students' increase mathematical proficiency. The three areas of concern emerged; the lack of hands-on lessons provided by the district textbook, teachers focused primarily on rote work, and grade level specific content was not clearly defined at the building.

Development to Support the Study

The study began developing as a direct result to the district's school profile of Mirror Lake Elementary School. Weekly meetings with Kim Prothero for a period of one school year provided ongoing communication and dialogue about current curriculum instruction. Prothero provided the author with direction on EALR alignment and intervention lessons. The author provided Prothero with classroom examples of textbook inadequacy. Prothero would then analyze the classroom data and provide the author with sample lessons aligned with the EARL's.

A collection of classroom based assessment provided Prothero and the author, evidence that current-teaching practices (relying heavily on the textbook) inadequately prepared students to meet academic standard in many mathematical strands, particularly in geometry and probability. The classroom based assessment results were confirmed by the WASL results distributed the following August. The following school year Prothero and the author still maintained frequent communication. Communication focused on lesson materials in addition to achievement gaps previously identified. The author of this project clearly relied on Prothero's research, data analysis, curriculum modifications and suggestions, and the lessons Prothero modified for classroom use. To further strengthen the findings of Prothero, the author conducted a study using control groups. The control groups were designed to see if the supplemental geometry and probability units increased student achievement. Students who participated in only traditional textbook instruction were compared with those students who received both traditional textbook instruction and supplemental units.

Procedures used to Select Materials

Computer search programs were used to obtain literature and research that was relevant to the topic. The parameters used to gather information focused on: research within the last ten years, articles and websites that supported and opposed traditional textbook instruction, articles with key words such as manipulatives, constructivist, balanced math program, National Council of Mathematics standards, Washington State Essential Academic Learning Requirements, and geometry and probability lessons. The Educational Resource Information Center (ERIC) and Proquest were the primary sources used to review and obtain current and background knowledge. Other resources such as the Office of Superintended of Public Instruction Mathematic Sites, Washington State Tool Kit, Kim Prothero (Federal Way District math specialist), and the Northwest Regional Educational Laboratory were used in the development of this project.

Planned Implementation of the Project

The grade four model of mathematics curriculum aligned with Washington Sate Essential Learning's and instructional strategies developed for this project was incorporated into lesson summaries presented in chapter 4. The model was field tested and used in two grade three classrooms and two grade four classrooms. For a comparison, four controlled groups were formed. Control Group A (grade three) and Control Group C (grade four) both received textbook curriculum with an extensive number of supplemental curriculums organized by Prothero and the author of this project. Control Group B (grade three) and Control Group D (grade four) both received traditional classroom instruction from the textbook with few supplemental materials. Assessment results for control groups A and C can be compared to test results for controlled groups B and D in chapter five.

CHAPTER FOUR
THE PROJECT

Washington State reform asked administrators and teachers to align curriculum with State identified goals, then to provide students with meaningful opportunities to learn. The project consists of *pre*, *during*, and *post* accumulation. The *pre* reflected the work of analyzing building assessments, pinpointing current teaching methods, gathering curriculum resources, identifying mathematics stands, and collaborating with colleagues. The *during* was the development of a supplemental geometry and probability unit. The *post* accumulation consisted of collecting State and District assessments and analyzing the data.

Chapter four has been presented in two units, to coincide with state requirements and guidelines, including:

1. Supplemental Geometry Unit: Lesson summaries
2. Supplemental Probability Unit: Lesson summaries

Supplemental Geometry Unit in Alignment with State EALR's

The supplemental geometry unit was designed in conjunction with the materials already selected by the classroom teacher. The unit utilized resources such as Marilyn Burns geometry, Addison Wesley textbook, and advice and lessons provided by Federal Way School District Math Specialist Kim Prothero. The lessons were aligned with the grade level benchmarks.

As Johnson stated, it is important to continually assess how students understand how mathematical terms fit with the understanding that is common to the way these words are used in the discipline (p. 34). With Johnson's finding, the author incorporated into each lesson a review of geometry language used in previous lessons. It is important to consistently expose and revisit the vocabulary and concepts taught. This strategy allowed each student an opportunity to further find his/her own mathematical understanding. State and district assessments require that the students communicate an understanding of content specific vocabulary.

It is important to look at the unit as a progression of student discovery and ideas. Day One lesson pre-assessed the students' previous knowledge of geometry. This first lesson gave the teacher a clear picture of each student's current knowledge. The students were asked to write words or draw pictures that he/she thought were related to geometry. On Day One, students created a personal geometry dictionary to use throughout the course of instruction. A list of important vocabulary and definitions can be found in Appendix A. Vocabulary building was essential for the students to build upon each day, as well as revisit previously learned words and concepts.

Day Two provided students with an opportunity to discover objects and terms rather than teacher directed definitions. The objective for this lesson was that students discover polygons. This lesson set the stage for the students understanding of the relationships and commonalities identifiable between different objectives. The lesson also enabled students to formulate definitions that were created by his/her own understanding of the objects. The textbook, classroom dictionaries, and Office of Superintendent of Public Instruction (OSPI) vocabulary list confirmed the student-defined definitions. A meaningful method of learning is when a student creates his/her own understanding, and then is given the opportunity to remedy misconceptions or validate findings. The polygons were then placed on butcher paper and the teacher used the chart to clarify or revisit vocabulary throughout the unit. The EALR's used were 1.3, 4.3 (OSPI, 2001).

Day Three was a continuation of Day Two, which discussed in great detail polygons. More content specific language was discussed. Students described objects using mathematical language. For example, instead of referring to corners, the student used the term vertices. Next, the students used geoboards to recreate the objects found from the previous lesson. Geoboards allowed students the opportunity to engage in tactile discovery. Students began to visualize objects by parts, such as a line-segment, rather than whole objects. This was part to whole, rather than a whole to part concept. The EALR's covered in this lesson were 1.3, 4.3 (OSPI, 2001).

Day Four continued to revisit previous vocabulary along with introducing space and plane figures. Students were shown a number of space and plane objects. With partners, students discussed differences and likenesses between the objects. Given different environmental settings, each student created a T-chart listing space and plane objects. Through partner dialogue, students practiced using mathematical language to describe objects by using such vocabulary as; face, edge, volume, and vertices. The EALR's covered in this lesson were 1.3, 1.5, 4.3 (OSPI, 2001).

Day Five focused on understanding angles, primarily, right angles. Traditionally, students would be given a worksheet with pre drawn angles and be asked to identify each angle. This lesson allowed students to use real world objects to learn about right angles. First, the teacher integrated reading into the math lesson by reading Greedy Triangle, by Marilyn Burns. The book reviewed objects and angles.

This book was also used for writing. Students wrote and illustrated his/her own rendition of the story. Following the story, the teacher taught the difference between right, obtuse, and acute angles. The teacher discussed how to use a protractor and showed examples of varying triangles. After the lesson, the students were put in pairs. Students went around the room collecting evidence to support what a right angle might look like. Each pair received an overhead transparency to share findings with the entire class. The pair chose one object from the collected list to describe using mathematical language. The EALR's covered in this lesson were 1.3, 4.3 (OSPI, 2001).

On Day Six, the teacher demonstrated how to make two objects congruent. The teacher gave students varied objects and asked the students how he/she would determine if the objects were congruent. Students used content specific vocabulary such as: flipping, sliding, rotating, and turning. These words were added to the students' dictionaries. The teacher asked the students to draw lines on the objects demonstrating that one side of the object was congruent to the other side. The students discovered the concept of symmetry. The students brainstormed real life object that would require congruent sides and lines of symmetry. The students' lists were put on the overhead. Finally, the students created paper airplanes and tested his/her theory of congruency. The EALR's covered in this lesson were 1.3, 2.3, 4.3 (OSPI, 2001).

Day Seven through Day Ten consisted of math tessellation discovery. Using four different stations, students created and manipulated objects exploring tessellations. The stations provided opportunities to use varied art forms for tessellation creation, as well as, the use of computer software Tessel Mania. Throughout student exploration, vocabulary previously learned was revisited. It was exciting to hear students discussing objects using mathematical language. Important vocabulary was heard, such as; object can be flipped, rotated, turned, and slid together. The EALR's covered in this lesson were1.3, 4.3 (OSPI, 2001).

Day Eleven was an opportunity to assess student growth. The assessment described in Day One was repeated. The assessment completed in Day One was compared to the assessment given on Day Eleven. A textbook provided test was given, along with a teacher created test. The teacher created test asked student to identify objects and describe objects using mathematical language. Students also compared likenesses and differences of objects.

The author's recommended time frame for the unit was approximately 11 days averaging 30-40 minutes per day. The length of a unit will depend on the students' needs and teacher time allotment to daily lessons. The author recommends that the unit be taught earlier in the school year and then revisited in the middle of the school year. Then, prior to the WASL, students review his/her dictionary to refresh vocabulary terms and mathematical concepts.

Supplementary Probability Unit in Alignment with State EALR's

The second unit probability, incorporated lessons that centered on learning through manipulatives and games. The lessons familiarized and oriented students with specific terminology used with probability. The probability unit was designed to catch student interest, while teaching the key components.

Day One was a lesson for gauging the students' understanding of probability. The lesson used a large poster on the board labeled Impossible, Unlikely, Likely and Certain, used to post students' responses. The students were then given a set of events written on Post-it notes. The students had to choose where an appropriate placement of the note would be on the labeled poster. For example, some Post-it's stated the following phrases, "the sun will set tonight" or "the Seattle Mariners will win the World Series." The students made a guess of where he/she thought the teacher should place the Post-it. The teacher also wrote down content specific vocabulary heard as the students discussed and dialogued. Students then wrote the vocabulary down in a probability dictionary created the previous day. The EALR's covered in this lesson were 1.4, 2.3, 3.3 (OSPI, 2001).

Day Two and Three used the story *Jumanji* by Chris Van Allsburg. The teacher read the story aloud. In the story, Peter and Judy play a board game. The board game consists of rolling dice. The teacher had the students play a Dice game. Each student rolled two dice and recorded the sums of the two dice on a recording sheet. The objective of the lesson was for the students to discover that it is more probable to roll a six or seven rather than a two or three. Once students completed his/her recording sheet, the results were recorded on a class-recording sheet at the front of the room. Following the activity, the teacher reviewed vocabulary and revisited the probability concept. A writing component was also integrated. Students wrote a persuasive letter to the author Chris Van Allsburg. The letter was to convince him that instead of the number twelve, he should have chosen a more probable number for Judy and Peter to escape the jungle. The EALR's covered in probability lesson were 1.4, 2.3, 3.3. The EALR's covered in writing lesson were 1.4, 2.3, 3.2, 4.1, 4.2 (OSPI, 2001).

Day Four and Five continued to revisit and solidify the concept of probability. The difference between Day Three and Day Four was instead of using dice the students used spinners. The students were given a spinner with sections one, two and three (1, 2, 3) labeled. Section three was twice the size of sections one and two. The students made a prediction of what number might come up the most if given a 100 times to spin the spinner. Next, with a partner, the students spun the spinners and recorded which number the spinner landed on. The results were recorded on a graph categorized by one, two, and three. After approximately twenty-five spins, the students cut apart and attached each category to a class graph. The class graph was taken outside and each student's findings were taped together. It was clear that the spinner landed on three twice as much as one or two. Again, students discovered this element rather then teacher directed. The EALR's covered in this lesson were 1.4, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.2 (OSPI, 2001).

Day Five was a Marilyn Burns lesson titled, "Tiles in the Bag." In this lesson, the idea of replacement as a way to predict how many of each color are in a bag of color tiles. The brown bag held eight red and four yellow tiles. The number of tiles in and the two colors of tile (red and yellow) were told to the students. The number of each color used was not disclosed. The teacher recorded first what predictions students had regarding combinations of color; for example, one red and eleven yellow. Then, students individually pulled out one tile at a time. A student recorder recorded each sample. The students pulled out a sample and then replaced it back into the bag. The students were told that the procedure used was sampling with replacement. After a number of sampling opportunities, the contents were revealed. The students were provided with other bags and tiles in order to repeat the procedures. The EALR's covered in this lesson were 1.4, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.2 (OSPI, 2001).

Day Six was a continuation of Day Five. This lesson built upon students' experiences with methods of choosing fairly and introduced three ways to choose involving tiles in a bag. The students drew tiles, collected data, and analyzed which versions were fair games. The students were given three different versions. Each version had a different amount of colored tiles. Working with a partner, the students kept track of a "match" or "no match". A match meant the students drew out matching colored tiles. A no match meant the colors didn't match. The students took 20-25 samples of drawings and then decided whether or not this bag presented a fair game. The EALR's covered in this lesson were 1.4, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.2 (OSPI, 2001).

Day Seven was another Marilyn Burns's activity. This lesson expanded on the previously played spinner puzzles. However, in this lesson students were given a number of different faced spinners. The students discussed the spinner faces and discussed the probability of winning. Then, the students were given blank spinner faces and a set of statements. The students created a spinner face for each statement. For example, one spinner face had to meet the following statement: *a* is certain to win. Students then traded spinner faces and had to figure out which statement corresponded with which face. The EALR's covered in this lesson were 1.4, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.2 (OSPI, 2001).

Day Eight was a lesson adapted from Jerry Cwirko-Godycki, titled "Crossing the Mississippi." There are two versions. The first version divided the class into two parts, while the second version was between two partners. The author's choice was the second version. The students were given a worksheet with a dock and river on it. Prior to playing, each student got twelve boats to dock (used beans). Students placed the beans on the docks. The docks were labeled from dock one to dock twelve, in numerical order. Taking turns, each student rolled two dice. If the sum of the two dice were the same as one of the docked boats, then the boat could go to the other side of the river. The first person to move all boats from one side to the other, won. The students kept track of what sums they rolled each time on a recording sheet. Following the game, the recorded sheets were posted on a class graph. The students discovered that tossing a sum of seven was six out of thirty six, while the sum of three was two out of thirty six. The EALR's covered in this lesson were 1.4, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.2 (OSPI, 2001).

Day Nine was an assessment day. The students were given a written test that used each lesson as a foundation. Questions asked students to explain his/her thinking when given a tool (spinner). The purpose of the assessment was to have the students communicate his/her thinking using pictures and written expression.

The author's recommended time frame for the unit was approximately 9 days averaging 30-40 minutes per day. Length of unit will depend on the students' needs and lesson time allotment.

Both units, geometry and probability, required students to predict, explore, and investigate. Through the use of manipulatives, students were able to gather evidence that supported or changed his/her perception of geometry and probability. The units provided the necessary curriculum that filled the gaps presented in the textbook. Using the EALR's as a guide ensured that the teacher covered grade appropriate elements for each mathematics strand.

The District and State assessments supported the research conducted in chapter two of this project.

CHAPTER FIVE

PROJECT RESULTS

Introduction

Chapter Five consists of the following three sections:

1. Project Summary
2. Author's Conclusion
3. Future Recommendations

Project Summary

The purpose of this project was to determine if the Federal Way school district's adopted mathematics textbook provided mathematical lessons that allowed students to achieve the standard on state assessment in the areas of geometry and probability. Control groups were developed. Two groups received primarily materials and lessons provided by the textbook. The second control groups received additional supplemental materials and lessons, along with the district provided textbook. Marilyn Burns' probability and geometry mathematics series were used as supplemental materials. The author suggests that these units be purchased for exact implementation. (The geometry unit was organized and used for instruction for the past two years). The curriculum was implemented at grades three and four. Teacher recommendations were considered for utilization in the proceeding unit completion. Both units aligned Federal Way school district mathematics expectation and state benchmarks, as shown in the study overview.

All control groups were given either the Washington Assessment of Student Learning or ITBS, depending on the grade level. Results were then compared and analyzed for students meeting the standard. Following the results of this study, all teachers were required to attend mathematical trainings offered by Kim Prothero, and then supplement the textbook with geometry and probability lessons. This requirement came from the leadership and administration in the building.

Assessment Results

The author's observations of student learning, demonstrated that students better understood the concepts presented through the use of hands-on math. The level of student excitement and engagement of learning greatly increased. The hands on lessons provided a teaching structure that allowed teachers to more effectively teach and integrate the existing mathematics program. The supplemental curriculum provided a bridge for the current textbook gaps. The following testing results indicate growth.

2000-2001 Third Grade ITBS Scores

The percentage in the following chart indicates students that scored in the low, average, and high quartile.

Control Group A included the district provided textbook, the author's geometry and probability supplemental units, a recommended use of mathematical manipulatives, and teacher training in mathematical teaching provided by Marilyn Burns' math program and Kim Prothero. Control Group B included the provided geometry and probability textbook lessons. District textbook lessons provided few concrete manipulative use. The author's supplemental units were not used because the teacher chose to only use the textbook book required by the Federal Way school district.

Control Group A: Grade Three

Geometry	Low	Average	High
	10%	30%	60%
Probability	Low	Average	High
	10%	10%	80%

Control Group B: Grade Three

Geometry	Low	Average	High
	25%	67%	29%
Probability	Low	Average	High
	17%	54%	29%

The findings conclude that more students in Control Group A, which used the district textbook and interventions, reached the highest mathematical quartile indicating a higher understanding of mathematical concepts. As a result, less students demonstrated a low and basic understanding of the tested mathematical concepts. Control Group B, which used the only the district textbook, demonstrated a higher percentage in the average quartile reflecting students had an average understanding of the assessed mathematical concepts.

1999-2000 Grade Four WASL Assessment Scores

The percentage in the following chart indicates the percentage of students that met standard for the geometry and probability sections of the WASL test (this percentage does not represent how many students passed the entire mathematics section on the WASL). Control Group C included the district provided textbook, the author's geometry and probability supplemental units, a recommended use of mathematical manipulatives, and teacher training in mathematical teaching provided by Marilyn Burns' math program and Kim Prothero. Control Group D included the district provided geometry and probability textbook lessons. District textbook lessons provided few concrete manipulative use. The author's supplemental units were not used because the teacher chose to only use the textbook book required by the Federal Way school district.

Control Group C: Grade Four

Geometry	50%
Probability	73%

Control Group D: Grade Four

Geometry	36%
Probability	55%

The percentages of students meeting standard for Control Group C are 14% higher in geometry and 18% higher in probability than Control Group D. The Federal Way school district's recommendation did not require that mathematical gaps between textbooks and state EALR's be supplemented with additional resources. Assessment data appears to show that lower scores exist for students who did not receive additional supplemental materials along with the provided textbook.

Conclusion

Conclusions reached as a result of this project were:

1. The Control Groups demonstrated on district and state assessments that a higher percentage of students within the same service area will achieve greater mathematical gains when provided opportunities to develop a deeper understanding of mathematical concepts.
2. As summarized in Chapter 3 of this project, the research indicates the correct use of mathematical manipulatives and mathematical lessons that facilitate opportunities for students to construct his/her own meaning, will result in higher achievement.
3. The Control Groups A and C had a combination of factors: supplemental units for geometry and probability were used to fill the textbook curriculum gaps, mathematical manipulatives, and games were used to provide meaningful learning

opportunities. Adequate training for manipulatives was administered to the teacher by Kim Prothero; district math specialist and Marilyn Burns representatives. Ongoing communication was conducted with the classroom teacher and Kim Prothero. The project did not make a distinction between each individual factor's contributions to student achievement. However, the author concludes that the greatest factor was the mathematical training and education the teacher received from Kim Prothero and Marilyn Burns' representatives. The training provided the teacher with teaching strategies, supplemental materials, and classroom observations and teaching recommendations. This ongoing training and communication allowed the teacher to modify his/her teaching style to better teach the students.

4. Marilyn Burns stated in an interview by Terese Herrera "I would love to see more kinds of learning available to teachers about mathematics, in ways that weren't frightening" (p. 5). The project did not focus on the teachers' mathematical background or the teachers' prior mathematical training. The author made informal observations of teaching styles and concludes that the teacher's own understanding of mathematical reasoning clearly effects how disciplines are taught to students.

Recommendations

The results for both grade three and grade four control groups and non-control groups suggest that textbooks alone inadequately prepare students to meet the standard of state and national tests. As a result of this project, the following recommendations are suggested:

1. District curriculum needs to be in alignment with state EALR's for each mathematical strand.
2. Teachers need to be current and up to date with multiple grade level EALR's and benchmarks.
3. Math manipulatives should be used correctly and consistently throughout daily lessons.
4. Training of correct use of math manipulatives should be an ongoing service provided to the teachers.
5. Teachers should use the assessment results as an ongoing assessment of student understanding and teacher direction.
6. More consideration should be taken on the individual influences of each factor summarized in Conclusion number three.
7. The project could be conducted in varied school settings to assess factors such as poverty and race. Gender issues of students could also be assessed into the results.
8. The project could consider how students with special needs benefited from more hands-on lessons.

9. The project could consider the training and educational background of each teacher.

10. The project could include classroom-based assessment along with district and state assessment results.

11. A follow-up project, with a long-term study of the same students, could compare assessment results in grade four, then three years later in grade seven.

12. More lessons could be provided for both geometry and probability. Different supplemental programs and resources could be incorporated into the existing project.

13. Teachers' styles of content presentation could be analyzed for similarities and differences, as well as, effectiveness and ineffectiveness of students' understanding.

Pickreign stated, " the gap between standards expectations and actual textbook content continues to reflect the need for substantial change" (p. 243). Washington State's EALR's require students to raise the bar of mathematical understanding. Textbooks need to be chosen thoughtfully and carefully, while existing textbooks need to be compared and aligned with state standards. Teachers must fill the gaps and administrators must provide teachers with effective training and resources. Teachers need to be assessed for effective teaching styles and trained in a variety of content presentation. The EALR's have raised the level of high quality teaching and leadership that must take place in Washington State schools to assure each child a quality education.

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Geometry Word List for Supplemental Unit: Terms and definitions found on OSPI website

www.ospi.k12.wa.us

Congruent: Figures that have the same shape and size

Intersecting: Lines that meet at a point

Line segment: A set of points extending infinitely in opposite directions

Parallel: Lines that lie in the same plane and never intersect

Parallelogram: A quadrilateral with opposite sides parallel

Pentagon: A five-sided polygon

Polygon: A closed plane figure having three or more straight sides

Quadrilateral: A four-sided polygon

Rectangle: A parallelogram with right angles; a square is a special rectangle

Rhombus: A parallelogram with all four sides equal in length

Right Angle: An angle whose measure is 90 degrees

Sphere: A closed surface consisting of all points in space that are the same distance from a given point (the center)

Square: A rectangle with congruent sides

Trapezoid: A quadrilateral that has 2 parallel sides; an alternate definition is a quadrilateral with at least 2 parallel sides (there is no common agreement on a definition of a trapezoid)

Turn, Slide, Flip, Rotate:

Turning a figure around a given point

Vertex-Vertices:

Point at which two line segments, lines, or rays meet to form an angle

Appendix A

Sample Supplemental Geometry Lesson

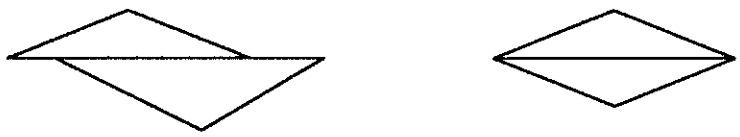
Lesson Day 2:

Polygon Lesson by Marilyn Burns

(Use Marilyn Burns's Geometry for ¾ grade for more detailed instructions)

Lesson Objective:

Working as a team, the students will discover 14 different patterns of polygons. Divide the students into groups of four or five. Each group needs a stack of 60 pre-cut squares (4 inch by 4 inch), 30 squares of one color and 30 squares of different color. The students need to cut the squares at a diagonal. Using four triangular pieces, the students will scotch-tape the four triangles together too create the polygons. Triangular sides must be flesh with other pieces, no overlapping (non-example) (example)



Have students work together and communicate his/her findings so that duplication does not occur.

Provide large butcher paper, so that each group can display and categorize their findings according to triangle, quadrilateral, hexagon, and pentagon. Have each group present their findings and discuss the strategy they used as a group to categorize the objects. The teacher may have to clear-up misconceptions.

Hang-up the charts up around the room for reference throughout the unit.

Materials:

- Three hundred pre-cut squares. 150 of each color.
- Multiple rolls of scotch-tape
- Butcher paper

Links to EALR's:

Third:	1.3
Fourth:	1.3, 4.3

Appendix B

Lesson Day 3:

Lesson:

Review polygons: Discuss how pentagons, quadrilaterals, triangles, and hexagons are all polygons, but because of their characteristics they have different names. Refer to polygon as a "family name" like "Smith". The pentagons, quadrilaterals, triangles, and hexagons are like children (they are each uniquely different, but belong to one family unit "Polygon".

When discussing the objects, discuss line segments and vertices to help explain the likeness nesses and differences between the polygons.

Using a tangram to practice creating shapes out of triangles. Distribute the tangram worksheet. Make sure that students cut carefully each piece and initialize each piece so that student pieces do not get mixed up. First review the following shapes, then call out a shape and have each student try to create the shape using as many or as few of the tangram pieces as they would like. As a final activity, have the students use all the pieces to create one large square.

*Shapes: parallelogram, hexagram, square, rectangle, rhombus, trapezoid

Part II.

Each student needs a geoboard and a handful of rubber bands. Use the rubber bands to form line-segments. Call out certain objects and have the students construct the objects. Have students turn the boards around to show the teacher the constructed objects.

Materials:

- Tangram print out
- Scissors (per. Student)
- Envelop (store the pieces)
- Geoboards (per. Student)
- Rubber bands (approximately 5-10 per student)

Links to EALR's:

Third: 1.3, 4.3

Fourth: 1.3, 4.3

Appendix B

Essential Academic Learning Requirements Used in Chapter Four

(www.k12.wa.us/curriculumInstruct/ealrs/default.asp?iSubjectID=4)

EALR:

1.3 The student understands and applies concepts and procedures from geometric sense.

1.4 The student understands and applies concepts and procedures from probability and statistics.

1.5 The student understands and applies concepts and procedures from algebraic sense.

EALR:

2.3 The student uses mathematics to define and solve problems, formulate questions, and define the problem.

EALR:

3.1 The student uses mathematical reasoning to analyze information.

3.2 The student uses mathematical reasoning to predict results.

3.3 The student uses mathematical reasoning to draw conclusions and verify results.

EALR:

4.2 The student communicates knowledge and understanding in both everyday and mathematical language. The student gathers information.

4.3 The student communicates knowledge and understanding in both everyday and mathematical language. The student organizes and interprets information.

EALR:

5.2 The student understands how mathematical ideas connect within mathematics, to other subject areas, and to real-life situations. The student relates mathematical concepts and procedures to other disciplines.