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An Integrated Math Curriculum Designed to Develop Problem Solving Skills in Third Grade Students

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AN INTEGRATED MATH CURRICULUM DESIGNED TO DEVELOP PROBLEM SOLVING SKILLS IN THIRD GRADE STUDENTS

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by

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ABSTRACT

AN INTEGRATED MATH CURRICULUM DESIGNED TO DEVELOP PROBLEM SOLVING SKILLS IN THIRD GRADE STUDENTS

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The effectiveness of a curriculum integrating math, manipulative use, writing, drama and the visual arts was examined. The information gathered through research articles and case studies was used to create an integrated math program. The focus of the project is to strengthen problem solving and critical thinking skills of third grade students. The project is designed to supplement materials and textbooks teachers are currently using in their classrooms. Implications for future areas of research are discussed.

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Chapter One: Introduction

Overview

As a third grade teacher, the author has noticed that many students at this grade level struggle when trying to solve math story problems. The Federal Way Elementary Curriculum, using the Addison-Wesley math series, focuses primarily on basic skills between kindergarten and the second grade (Curriculum, Instruction and Assessment, 1999). During the first three years of schooling, students are given opportunities to explore math through free time centers, manipulative activities, etc. However, they are rarely given a specific, paragraph-form problem which must be solved with mathematical computations. The author has observed that when word problems are given to children between kindergarten and second grade, they are usually in an oral format with the teacher reading the problem to the class, leading a group discussion, and then solving the problem on the board with the entire group of students. Before the third grade, students rarely, if ever, complete math story problems on their own. Through her own teaching experience, the author has seen that by the beginning of the third grade, students have not developed the literacy skills necessary to decipher and successfully solve story problems. Many children have difficulties comprehending story problems, much less solving them. The Iowa Test of Basic Skills (ITBS) is a standardized test administered to schools throughout the United States. In 2001, the third grade students (as a group, not individually) scored in the 69th percentile on the math section of the ITBS. The national average for this section was set at the 50th percentile. Score results received at the end of 2001 indicate that students answered most of the computational questions correctly, but

struggled with the problem solving questions (Federal Way School District, 2002).

Purpose

The author has observed that sole use of the materials and directions supplied in the Addison-Wesley math kit is not enough to help third grade students reach the problem solving and critical thinking academic requirements set by the Federal Way School District. Using just the materials supplied, the author has noticed that many students do not meet the district's academic requirements. The purpose of this project is to create a teacher's guide which supplements the math materials third grade teachers at the author's school are required to use. The goal of this guide is to teach problem solving strategies and strengthen critical thinking skills in third grade students.

This teachers' guide shows how to teach problem solving and critical thinking through the integration of writing, manipulative use, drama and the visual arts. This guide is to be used in conjunction with the Problem of the Day Black-Line Masters found in the Addison-Wesley Third Grade Math Kit. These black-line masters are a series of word problems (one for each day of the school year) designed to review concepts taught in the Addison-Wesley third grade math textbook.

Limitations

This project is for the instruction of third grade students. The background information used to create this project is limited to studies a discussed in Chapter Two of this project, one third grade classroom in the Federal Way School District that the author was responsible for during the 2001/2002 school year, and the Addison-Wesley Third Grade Math Kit. The only portion of the math kit used in this project are the Problem of

the Day Black-Line Masters. The content areas integrated in this project are math, manipulative use, writing, drama, and the visual arts.

Scope

Though this project is specifically designed for third grade teachers using the Addison-Wesley Math Kit, it is an excellent resource for other teachers. Teachers can take the approaches used in this project and apply them to other grades and math series. The concept of integrating problem-solving with writing, manipulative use, drama and the visual arts is not limited to the author's classroom. The studies discussed in Chapter Two cover a wide range of grade levels. Moreover, though all the articles discussed in Chapter Two support an integrated curriculum, each article was completely unique in terms of teaching style, math textbook used, class size, regional area, and socio-economic background. This project is appropriate for anyone teaching problem-solving strategies and critical thinking skills.

Definition of Terms

Decoding. reading and understanding the meaning of each word in a passage (Rich and Blake, 1994)

Cue Words. words which trigger a certain mathematical operation (Parmar and Cawley, 1994)

EALRs. the Essential Academic Learning Requirements

Interactive Theory. the idea that feedback and support vital to academic learning is given when the teacher, students and others involved work on a dramatic production (Bidwell, 1990)

ITBS. Iowa Based Test of Student Assessment (Federal Way School District, 2001)

Literacy. the reading skills necessary to form meaning out of a written passage and the writing skills necessary to clearly express ideas, thoughts and beliefs (Curriculum, Instruction and Assessment, 1999)

Logical Deductions. a reasonable solution for a given question (Kay and Charles, 1995)

NCTM. National Council of Teachers of Mathematics (Burns, 1995)

Presentation Options. the four different ways in which material can be presented to students: speech, written form, some sort of visual display, or through manipulative (Parmar and Cawley, 1994)

Primary Students. kindergarten, first, second and third grade students (Curriculum, Instruction and Assessment, 1999)

Representational Technique. taking the written data presented in a word problem and displaying it in a different form (Jitendra and Yan Ping, 1997)

Response Options. the four different ways that students can explore new material and display their knowledge of it: speech, written form, through identifications or through manipulative (Parmar and Cawley, 1994)

Schema. a person's knowledge framework for a typical situation (Bidwell, 1992)

Story/Word Problems. paragraph form questions which are solved by applying mathematical concepts (Curriculum, Instruction and Assessment, 1999)

Strategic Reading. reading for a purpose (Bidwell, 1990)

Strategies. techniques used to solve word problems (Winograd, Ken, 1992)

Strategy-Training Procedure. teaches students basic problem-solving strategies

(Jitendra and Yan Ping, 1997)

Transmediation. the process of moving information from one communication system to another (Hoyt, 1992)

Task Variations. sequencing word problems so that easy skills are taught before more difficult ones (Jitendra and Yan Ping, 1997)

Summary

The remainder of this project is organized as follows: Chapter Two includes a review of the literature researched. Chapter Two is divided into seven sections. The first section is an introduction of the literature. The second section details the third grade learning requirements in math. The third section discusses the literature on integrating writing and math. The fourth section discusses the literature on integrating manipulative into the math curriculum. The fifth section discusses the literature on integrating dramatic and visual arts into the math curriculum. The sixth section discusses the literature on helping learning disabled students learn problem solving skills. The final section of Chapter Two is a summary on the review of literature. Chapter Three includes the procedures involved in developing this project. This chapter explains the author's reasons for designing this project and the importance of this project. Chapter Four includes the supplementary guide designed to accompany the Addison-Wesley Problem of the Day Black-Line Masters. This guide shows how to integrate mathematical word problems,

manipulative use, writing, drama, and the visual arts to teach problem solving and critical thinking skills to third grade students. Instructions and sample lessons plans using some of the black-line masters are included in this chapter. Chapter Five contains a summary of the project, conclusions, and recommendations.

Chapter Two: Review of Literature

Introduction

By the end of the third grade, students are expected to be able to solve story problems and explain their solution using either written or verbal language (Curriculum, Instruction and Assessment Department of the Federal Way Public Schools, 1999). Effective problem solving includes logical thinking, an ability to organize data, and the integration of reading comprehension and math computational skills. To help foster the development of these skills, a program is needed that will allow students to utilize all areas of their learning.

The author has observed that students need opportunities to develop their critical thinking skills through writing, verbal discussions, dramatic presentations, drawings, and by manipulating materials. Students must have an opportunity to reorganize data in a way that makes sense to them. Students also need to be taught how to pull the main points out of a story problem, and how to choose the correct algorithm to reach a proper solution. The studies discussed in Chapter Two led the author to conclude that if a student is to truly comprehend and be successful with story problems, then an integrated curriculum which incorporates writing, drama, manipulatives, computational and comprehension skills is necessary.

Essential Academic Learning Requirements in Math

The Curriculum, Instruction and Assessment Department of the Federal Way Public Schools (1999) has established district grade level expectations. The district's grade level expectations provide the learning requirements of each grade. These requirements are based on Washington State's Essential Academic Learning Requirements (EALRS). The problem solving grade level expectations for third grade

students are:

1. The student uses mathematics to define and solve problems.
    a. explores and uses problem-solving strategies: Looks for a pattern, constructs a table, makes an organized list, acts it out, draws a picture, uses objects, guesses and checks, works backward, writes and equation, solves a simple problem, makes a model
    b. Interprets and communicates mathematical information using graphs, charts and diagrams
    c. Expresses mathematical ideas clearly in written language
2. The student uses mathematical reasoning.
    a. Validates thinking by using models
    b. Makes and tests predictions to support or contradict them
3. The student uses mathematical knowledge and understanding in both everyday language and mathematical language.
    a. Collects and organizes mathematical information
    b. Expresses ideas using mathematical language

Integrating Writing Into The Math Curriculum

Carol A. McGehe (1991) stresses that students must have an opportunity to discuss and write about math if they are to truly understand the concepts taught in school. To support her claims, McGehe refers to the National Council of Teachers of Mathematics (NCTM) who stated in 1989 that "Writing is a communication skill that has been used too infrequently in mathematics. It is particularly useful because it allows a child who is uncomfortable in oral situations to express understanding in a less public forum" (p. 36). Through writing, students are able to discuss new concepts, explore concepts which may be confusing or interesting to them, and share their ideas and interpretations with others. Moreover, students who are uncomfortable discussing math concepts verbally, have the freedom of doing so in a written format. McGehe adds that integrating writing into the math curriculum can help "students become better communicators and learn to express themselves, mathematically and otherwise, with

greater confidence, clarity and ease" (p. 36). By integrating writing and math consistently, students develop the skills necessary to explain and clearly present their knowledge.

McGehe (1991) provides several strategies for incorporating writing into the math curriculum. She first discusses two strategies proposed by the NCTM. One strategy involves peer letter writing, where students engage in a penpal activity, and write about weekly math lessons. The other NCTM strategy involves journal writing. Math journals allow students "to reflect on their learning or to express any confusion they are experiencing in specific areas of mathematics instruction" (p. 36). McGehe describes word webs, which encourage students to brainstorm their thoughts, questions, observations and feelings on a given mathematical strand. Her next strategy discussed is a Guided-Response Strategy which utilizes George Polya's Problem-Solving Plan. This plan is a student response worksheet which guides students to answer the following prompts:

> Step 1. Understanding the Problem--Rewrite the problem in your own words, underlining the key information. What is the question?
> Step 2. Devise a Plan--Which problem-solving strategy will you use?
> Step 3. Carry Out Your Plan--Show your strategy and work below. Be sure to organize your work and label the parts. Box in your solution.
> Step 4. Look Back--Did you answer the question being asked? Is your solution reasonable? Can the problem be done using a different strategy? Show it below (p. 38).

These questions help students focus their writing so they do not loose track of the question at hand and branch off into unrelated areas. However, referring to Montague (1992), Jitendra and Yan Ping (1997) warn, that Polya's strategy "may be deemed ineffective in facilitating the problem-solving process for the poor problem solver. Without specific strategies, the guidelines implied in [Polya's] model may not be useful,

especially for students with mild disabilities and at-risk students, who have few resources to guide their problem-solving performance" (p. 435). Another strategy used by McGehe is to allow students to create and illustrate their own story problems. She believes that "problem writing does more than engage kids in writing--it has a far-reaching impact. As students take ownership for the work they create, they begin to take more pride in the quality of their work and achieve a higher level of self-esteem" (p. 38).

Beth Howard Fuqua (1997/1998) further explores the topic of journal writing in her article, Exploring Math Journals. Instead of working with individual math journals, Fuqua experiments with a class journal. The journal is used to solve every day math problems that occur naturally--such as making a chart to determine which students wanted a birthday cupcake decorated with either red, black, yellow or pink icing. Students discuss the problem and form a solution using pictures, graphs, charts or words. Problems are solved in small groups or as a whole class. Either way, the results are discussed as an entire class.

Fuqua (1997/1998) found that students were more motivated to solve problems which occurred naturally, rather than scripted textbook problems which had little or no relation to their every day lives. She observed that when children are given an opportunity to work on real-life problems that are interesting to them, they "will gladly record how they solved [the] problem and share it with the class" (p. 76). Most importantly, according to Fuqua, writing helps students understand mathematical concepts on a deeper level. This is because students are able to reorganize information in a way that is more meaningful to them. Fuqua states that "This process [of writing] makes [children] think about and use various symbols (including letters, words and drawings) to represent their thoughts in a meaningful way" (p. 77). Moreover, through

class journalling sessions, Fuqua notes that her students were involved in several mathematical skills at one time. She saw that when journaling, students were actively involved in reasoning, comparing, counting and other mathematical concepts" (p. 77). Class journals do not only impact students' mathematical abilities, they also help develop students' communication skills. Using journals, students "are exploring the many uses of language as they discuss, explain and record their problem and how they solved it" (p. 77).

Marilyn Burns (1995) explains why it is vital that children learn to communicate in math. Quoting the National Council of Teachers of Mathematics (NCTM), Burns explains that "Young children learn language through verbal communication; it is important, therefore, to provide opportunities for them to 'talk mathematics'...Writing about mathematics, such as describing how a problem was solved, also helps students clarify their thinking and develop deeper understanding" (p. 13). The more opportunities a student is given to discuss math, the deeper their level of comprehension will be. Writing is a process which allows students to "reinforce their learning" (p. 24). Burns believes that writing has such a powerful effect on comprehension because "Writing encourages students to examine their ideas and reflect on what they have learned. It helps them extend their understanding. When students write about mathematics, they are actively involved in thinking and learning about mathematics" (p. 14). Marilyn Burns' book incorporates a series of ideas and strategies for integrating writing into the math curriculum.

Burns (1995), stresses that writing is not only beneficial to students. She believes that student writings can be used by teachers as an assessment tool. According to Burns, "students' writings [provide] a window into what they [are] learning, what they

[understand], how they [approach] ideas, what their misconceptions [are] and how they [feel] about their math learning" (p. 2). These observations are equally, or more valuable than the results of a math test. Traditional writing is not the sole form of expression for students to explore during math class. Burns encourages students to use words, numbers, pictures or a combination of all three (p. 18). The idea is to allow students to work through math problems with any format that they are the most comfortable with. This includes allowing students to work alone or with a partner. When students are comfortable with it, team work is beneficial because it allows stronger students to "share the knowledge" (p. 27) they possess. Less competent students benefit by having "gaps in their understanding filled" (p. 27) by group experiences.

Students are also given the option of working with manipulatives, so that they have "concrete models to use and explore" (p. 21). Burns (1995) feels that this type of writing and exploration helps students "learn that they have the ability to face new problems and work their way to solutions. They learn that being able to explain a procedure is as important as being able to apply it. They learn to think and reason...not merely memorize and practice" (p. 24). Rather than the rote learning of a skill through drill and practice, students become critical thinkers, understanding why and when skills are applied to specific problems. Moreover, through writing, students gain self-awareness about themselves as learners. Burns notes that writing helps "students think more deeply and clearly about mathematical ideas and also about their own learning" (p. 1).

Jeanine Ryan, Peter Rillero, Jo Cleland and Ron Zambo (1996) introduce a daily writing strategy which helps students think critically about math. Ryan et al.'s strategy, titled "Write Now", uses open-ended, opinion-based questions to review math lessons. An example of such a question is, "Which would be better to use in planning to buy food

for a restaurant, ratio or percentage?" (p. 81). To answer such a question, students must expand on information they have gained from a previous math lesson and incorporate some of their own background knowledge. The benefits of such questions is that they "create an environment in which students can relate subject matter to their everyday lives and in turn see the relevance of what they're studying" (p. 81). After students have finished writing, they are encouraged to share their responses with the class. Through these open-ended prompts, students are "increasing their writing skills, articulation abilities and knowledge of math" (p. 81). Communication, writing skills and knowledge, three key areas of problem solving are being developed with this strategy.

As a general rule, "Negative remarks, by either the teacher or students, are discouraged" (p. 78). This creates an open environment for "children to express their opinions and use their imaginations to the fullest extent possible" (p. 78). Students are not hindered by a fear of being ridiculed or a fear of being told their answer is wrong. This accepting environment is key because, as Ryan et al. point out, "Not only does the approach help empower students by allowing them to share their ideas, but it also increases their interest in and knowledge of the subject they are studying" (p. 78). Students' writings and class discussions are excellent assessment tools for teachers. Writings and discussions "allow the teacher [to] see whether the children have understood the lesson from the day before" (p. 78). Students' written and verbal responses, in turn, dictate future lessons. The teacher will be able to determine whether or not a review lesson is needed or whether students are ready to move on to more advanced material.

Sue Brown (1997) also uses writing to make a connection between math and the everyday world. She uses math journals to reveal relationships between math lessons

and the outside world. According to Brown, "Students frequently view mathematics as a classroom subject unrelated to their daily lives--something that occurs Monday through Friday between 9 A.M. and 3 P.M. A student journal provides a structure by which children can discover and communicate relationships between school mathematics and real life" (p. 53). As students make these connections and write to discover how math can be applied to daily life, they are building on critical thinking skills. Writing, as a reinforcement, may be an essential element to critical thinking and problem solving. Referring to Ford (1990), Brown suggests that "Teachers can help children become better thinkers by using the children's own language to teach mathematics" (p. 51). Brown also refers to Lamme (1984), Hipple (1985), and Fulwiler (1987) who stress that "Journal writing can extend and enhance children's self-expression, critical-thinking skills, and communication skills" (p. 51). When students write in their math journals, students are reshaping knowledge in a way that is more meaningful to them. In this way, comprehension increases. Referring to Irons and Irons (1989), Brown suggests that "When children create their own unique knowledge, they gradually will develop a picture of concepts and ideas that will deepen their understanding of mathematics" (p. 51).

Cynthia Kay and Jim Charles (1995) reinforce the importance of combining writing and math. They believe that writing can "Provide students [with] an opportunity to reframe newly acquired knowledge into their own words or sketches" (p. 22). Students are able to reinvent new material, changing it into a format that is more understandable to them. Writing can also "permit students to review, reiterate and deepen their understanding of a math concept" (p. 22). Instead of simply learning a new concept, completing a worksheet and then moving on to a new topic, students are given an

opportunity for reflection. Writing also encourages "clarification and consolidation of new information" (p. 22). Through writing, students are able to verbalize which aspects of a new concept are unclear to them and which ones make sense. This provides students with an opportunity to seek extra help, if needed, or reaffirm what they already know.

Kay and Charles (1995) explain that writing may also "Ensure students will order their thoughts about an object, thus allowing a way, and practice, to order their thoughts about thinking" (p. 22). Writing helps students become more logical in their reasoning and deductions. Writing provides students with an opportunity to work through their ideas, organizing them in a clear and concise manner. For teachers, students' writings can provide insights into "the various ways...students construct an understanding of a math concept or process" (p. 22). This information can aid teachers in lesson planning and help teachers determine students' strengths and weaknesses.

Kay and Charles (1995) warn teachers that if writing is to be effective in a math class, students must have an opportunity to write "at least twice a week" (p. 22). It is through consistent use that students will reap the benefits writing offers. Teachers must also provide "opportunities that encompass a wide variety of writing assignments" (p. 22). Requiring students to complete different types of writing assignments will help students develop their abilities to apply logical deductions to a variety of problems. Kay and Charles encourage teachers to use writing "in place of--not in addition to--typical class work" (p. 22). Rather than act as a supplementary assignment, writing can effectively replace worksheets and rote assignments. The authors' final advice to teachers is that they should respond "to students' writings with encouraging comments, not grades" (p. 22). This will motivate students rather than hinder them. Students will be more willing to take risks and write freely if they are not concerned about spelling,

punctuation or receiving a low grade if for an incorrect answer. If students cannot use words to describe or explore a concept to their own satisfaction, they are encouraged to incorporate pictures into their work. No limitations should be placed on students as they work towards developing an understanding in math.

Ken Winograd (1992) believes that writing most effectively incorporates critical thinking when students are allowed to write their own story problems. Students were asked to write and solve their own story problems. Once the task was completed, they were invited to share their work in small, cooperative groups. Winograd discovered that by creating and sharing story-problems, students were engaged in thinking critically four different ways: First, students created "Problems containing new math concepts" (p. 64). By doing so, students had an opportunity to learn alternatives ways for solving unfamiliar material. Secondly, students created "Problems that required knowledge of a particular math procedure" (p. 64). This allowed students to reinforce skills or, if they had not yet learned the procedure, to be exposed to a new math skill. Third, students created "Problems that require problem-solving knowledge the student does not yet possess" (p. 65). Winograd uses the example of a student whose problem involved mileage calculation. The student had trouble solving the problem, because she had not yet learned how to use a chart to organize information. Because of the problem she created on her own, she developed a new problem-solving strategy (organizing data with a chart). Finally, students created "Problems the students understood but made minor errors in solving" (p. 65). These students made small errors which were not related to comprehension. For these students, the benefits of checking and re-evaluating their responses were reaffirmed. Students also extended critical thinking skills by developing creative ways to make their story-problems challenging. To make their problems more

challenging, students used strategies such as adding extra numerical or non-numerical information or including large, difficult numbers into story-problems.

Most students found student created story-problems to be more interesting and challenging than textbook problems. This is because "textbook problems tend to be grouped according to a common concept, skill, or procedure. After doing one or two problems on a textbook page...it was not difficult for students to figure out the required operation for the remaining problem" (p. 66). Student created problems, in comparison, varied greatly in terms of difficulty and skill required to solve the problem. Also, interest levels were high because students created problems around every day issues that interested them. Instead of solving a textbook problem that was completely unrelated to their daily lives, problems came right out of students' every day worlds. Because of the high level of critical thinking involved in creating story problems, Winograd (1992) suggests that story-problem writing should be "a regular and core component of the mathematics curriculum" (p. 64). Problem writing does not have to remain solely an enrichment activity. It can be a main focus of the math curriculum.

Using Manipulatives To Explore Math

Manipulatives give students a concrete representation of mathematical concepts. Using manipulatives, students are able to physically explore the rules, limitations, and relationships of mathematics. Quoting Thompson (1994) Diane McCarty (1998) explains that "effective mathematics instruction in the elementary grades incorporate the liberal use of concrete materials" (p. 369). If students are not given an opportunity to physically explore math concepts, it will be difficult for them to develop total comprehension of math concepts. This is because, as McCarty points out, "creating hands-on math

activities for children is beneficial in formulating a knowledge base for mathematical thinking" (p. 369). Manipulatives provide for deeper levels of critical thinking and understanding.

Sandra Waite-Stupiansky and Nicholas G. Waite-Stupiansky (1998) agree that the use of manipulatives is a key element of mathematics instruction. However, they warn instructors that manipulative activities must entail critical thinking. Waite-Stupiansky & Waite-Stupiansky advise teachers that "busy hands don't always mean busy minds. We need to analyze what we ask our children to do in 'hands-on' math, and make sure that they are not simply going through the motions" (p. 85). To be effective, manipulative use must have a specific focus. Otherwise, teachers may fall into the trap of creating assignments which are mere time-fillers, occupying students attention and providing for very few learning experiences. To help teachers effectively use manipulatives in the classroom, the authors provide the following guidelines:

> 1. Plan for opportunities for students to share their thinking about hand-on activities through oral communication.
> 2. Ask probing questions to focus students thinking when using manipulatives.
> 3. Think about appropriate places in lessons for students to use hands-on tools. Always try to use them to stretch their thinking.
> 4. When evaluating a hands-on activity, focus on children's learning. Ask yourself if students were engaged mentally, as well as physically in the activity (p. 85).

If students are to benefit from the use of manipulatives in the classroom, teachers must construct appropriate lessons using them.

Integrating Dramatic and Visual Arts Into The Math Curriculum

Integrating the dramatic and visual arts into the math curriculum is beneficial because, as Andi Stix (1994) points out, "Historical evidence abounds that people naturally integrate information in many different ways" (p. 264). Moreover, "the

multimodal approach to teaching conveys a deeper and truer understanding of mathematics...a multimodal approach can enable students to link verbal knowledge, visual imagery, and personal experience" (p. 264). Experiencing the same concept several different ways will help students gain a deeper understanding of the material covered.

Incorporating drama into the classroom can be a powerful tool. Sandra M. Bidwell (1990) quotes the Association for Supervision and Curriculum as supporting the integration of drama and other creative arts into the curriculum. According to the Association for Supervision and Curriculum, visual and performing arts improve "students' ability to create, experience, analyze and reorganize" data (p. 38). Through visual and performing arts, students are able to develop meaning, make connections between what they are learning in class and their own personal experiences, and communicate their learning to others. Linda Hoyt (1992) calls this process transmediation. Transmediation is defined as "the process of moving information from one communication system to another" (p. 581). Combining dramatic and visual arts with mathematics, students are processing information from a written word problem and expressing that information through role play, drawings, etc. This process is beneficial for students because, as Hoyt points out, "this process encourages learners to generate new meanings and expand existing ones" (p. 581). In effect, students are able to gain a deeper understanding for new material when they are able to manipulate it, look at it from different perspectives, and remodel that information into various formats.

Bidwell (1992) points to several reasons for integrating the arts and math lessons. The first reason relates to a student's schema, which Bidwell defines as a student's "knowledge framework for a typical situation" (p. 653). Bidwell argues that a student's schema "is activated by drama" (p. 653). When a student is encouraged to reshape their

learning into a dramatic presentation, they are constantly reevaluating, reorganizing, and critiquing new information. Moreover, as the student recreates new information into a dramatic presentation, the information takes on a more personal importance. Hoyt stresses that "Learning occurs when one creates a personal interpretation" (p. 584). This personal interpretation becomes part of the student's schema. Also, the student becomes aware of an audience, and the fact that they must relay their knowledge to an outsider. Students then begin to analyze the information to make sure their performance clearly communicates the information to an audience.

This growing ability to communicate information transfers into students' written work. Drama allows students to work with one piece of material repeatedly, looking at it from various perspectives. When students are asked to relate what they have learned in written form, they are successful. Hoyt (1992) explains that "Because of the dramatic interaction that preceded the writing, children are able to write with clarity and purpose" (p. 582). Bidwell (1990) also states that drama incorporates strategic reading. Strategic reading is defined as "Reading for a purpose" (p. 39). Through drama, students learn to read critically, skimming to pull out key components of a text, re-reading to clarify information, rewording information to make it easier to understand, etc. In effect, drama helps students learn and utilize key reading comprehension skills. Reading comprehension is a key component of problem solving. If a student cannot understand the word problem they are reading, they will when attempting to solve it.

Another reason Bidwell (1990) gives to support the integration of drama into the curriculum involves something which she calls an interactive theory. This interaction involves those working on the dramatic production: students, the classroom teacher, etc. Learning occurs when "Students and the teacher give feedback to one another" (p. 39).

Quoting Wells (1986), Hoyt (1992) stresses that "It is essential to provide opportunities for children to talk about what they are learning" (p. 582). Instead of working on a problem independently, students are now engaged socially. These discussions around mathematical concepts will develop students' comprehension. Stix (1994) points out that "Verbalization can be used to move the individual to a deeper level of understanding" (p. 264). Hoyt agrees and adds that through drama, students learn "that they are resources for one another" (p. 583). There is an opportunity to vocalize thoughts, garner feedback from others, and reshape ideas based on social interactions. Students are no longer limited to only one way of thinking (their own way).

Quoting Booth (1982), Hoyt (1992) argues that "Drama evokes higher order thinking, problem solving, feeling, and language as students strive to demonstrate their knowledge orally" (p. 581). Instead of simply reading something, processing that information internally and then writing a response, drama forces students to communicate that information to others. Instead of simply believing that they have a grasp on the material, they must find a way to share their learning with others (an audience). This process of verbalizing and sharing information allows for deeper meaning, because, as Hoyt points out, students are using " their bodies and their voices as ways of communicating their understandings. Transmediation occurs as they translate their knowledge into motion and verbal interpretation" (p. 581).

Like the dramatic arts, the visual arts can also help improve comprehension in math. Stix (1994) acknowledges that encouraging students to draw out math problems "using pictures, words, and numbers, also enhances the students' ability to define concepts and to present a clear, logical solution to a given task" (p. 266). Drawings give students a visual representation of math concepts. While drawing, students are engaged in

critical thinking: They are determining the best pictorial representation for a concept. Suzanne McConnell (1993) adds that drawings "assist learners to draw on, organize, and reflect on their prior knowledge in a positive way" (p. 269). This critical thinking process, along with the visual representation they have once their drawing is complete, gives students many opportunities to explore, test, and experiment with new concepts. This leads to deeper comprehension.

Quoting McConnell (1993), Rebecca Z. Rich and Sylvia Blake (1994) support this idea, stating that "Picture use does not have to be limited to single words, nor does it have to remain as purely a mental image. Rather, the learner can recode a range of facts and understandings into visible images that can be used as a bridge to enhance comprehension and learning" (p. 271). Drawing is such a powerful tool in math because, as McConnell points out, "drawings provide a visible and explicit record of learning which can be reflected on, altered, and developed" (p. 269). The visual arts do not only improve comprehension. There is evidence to suggest that integrating the arts into a math curriculum can help strengthen students' long term memory. Rich and Blake explain that "drawings can facilitate information processing and provide a permanent record of information constructed from text" (p. 274). Essentially, drawing serves two functions: It helps students solve math problems they are currently working on and it helps students retain knowledge so they are able to solve similar problems at a later date.

Helping Learning Disabled Students Develop Problem Solving Skills

Rebecca Z. Rich and Sylvia Blake (1994) explain that student who have reading or other types of learning difficulties often struggle with story problems more than average readers do. There are several possible reasons for this. First of all, "students with language and reading difficulties may have problems constructing meaning because of

slow and inaccurate word-recognition skills" (p. 271). In other words, since poor readers have trouble decoding story problems (reading and understanding the meaning of each word in the problem) they are unable to grasp what the problem is asking them to do. Secondly, "When not automatic, word recognition may require so much cognitive energy that limited resources remain for understanding" (271). Poor readers put so much time and effort into sounding out and reading each word that they do not have enough cognitive resources left over to create meaning out of what they have read. All their focus is on decoding and they are so overwhelmed with this task that they do not implement comprehension strategies. The third reason poor readers often struggle with word problems is that they "lack essential background knowledge in content areas, fail to activate the background knowledge they do possess, and have limited vocabularies and problems understanding abstract concepts" (p. 271). Because of this, poor readers often have trouble making connections between related concepts. Finally, poor readers struggle when solving story problems because "they are not strategic learners. That is, they neither flexibly select and apply strategies to enhance learning nor self-monitor and evaluate strategy use" (p. 271). This suggests that poor readers need to be taught how to effectively choose and assess problem solving strategies.

Asha Jitendra and Yang Yan Ping (1997) agree that problem solving is most difficult for "students with disabilities and at-risk students who have difficulties with reading, computation or both" (p. 412). They refer to 1989 NCTM reports which "identified problem solving as its number one priority" (p. 412). Problem solving is so important, because the critical thinking skills developed in mathematics transfer into daily life. Jitendra and Yan Ping quote Bottge and Hasselbring (1998) as stating that "knowing how to problem solve in mathematics enhances an individual's ability to

function in the context of everyday situations and work setting" (p. 412). When working with learning disabled students many teachers focus primarily on basic, computational skills. Until students have mastered these skills, problem-solving is usually not taught. Jitendra and Yan Ping believe that "For many students with disabilities, such mastery may never occur. However, ...word-problem-solving instruction can occur simultaneously with instruction in computational skills" (p. 434).

Jitendra and Yan Ping (1997) stress the importance of incorporating a variety of teaching strategies into a problem solving curriculum. In their article, Mathematical Word-Problem-Solving Instruction For Students With Mild Disabilities And Students At Risk For Math Failure: A Research Synthesis Jitendra and Yan Ping analyze several different strategies used to help learning disabled students learn to solve word problems. One strategy examined is a representational technique. Representational techniques entail taking the written data presented in a word problem, and displaying it in a different form. This form can be verbal, pictorial, or in a physical form such as a manipulative representation. A strategy-training procedures is a strategy that prompts students to learn basic problem-solving strategies. An example of a problem-solving strategy is one that entails "reading the problem aloud, paraphrasing, visualizing, stating the problem, hypothesizing, estimating, calculating and self-checking" (p. 424). Jitendra and Yan Ping's final strategy utilizes task variations. Task variations involve sequencing word problems so that "easy skills are taught before more difficult ones, to reduce student errors and frustration" (p. 426). Teachers also vary the word problem context so that students are not always solving the same type of problems. Jitendra and Yan Ping conclude by stating that each strategy meets a different educational need. Because of this, they feel "that problem-solving instruction must be highly integrated [including

variations of each strategy] and comprehensive" (p. 434).

Cynthia L. Wilson and Paul T. Sindelar (1991) report findings to suggest that direct instruction may be the best way to help learning disabled students solve word problems. Historically, learning disabled students have been considered incapable of solving word problems. Referring to Cawley, Fitzmaurice, Shaw, Kahan, & Bates (1978, 1979), Cawley & Goodman (1968, 1969) and Englemann (1977), Reston and Sindelar point out that the "Mathematics curricula of students with mental disabilities... lack adequate, strategic, and sequenced instruction" (p. 512). Learning disability programs display an "absence of strategy teaching and step-by-step procedures for teaching word problem solving" (p. 512). Avoiding problem solving, the majority of learning disability curricula focus on the "rote development of computational skills" (p. 512). Reston et al.'s study compared several different teaching strategies. They found that learning disabled students made the most progress when working in "a program constructed to model explicitly and teach each step in the word-problem-solving process" (p. 518). When learning disabled students are given the tools necessary to solve word problems, they are successful. However, they require clearly laid out instructions, along with guidelines of when to apply which strategies to which types of problems.

Though strategy instruction may benefit students with learning disabilities, Parmar and Cawley (1994) warn that teachers should avoid strategy instruction which focuses mainly on cue words. Cue words are defined as words which trigger a certain mathematical operation. Parmar and Cawley use the example of words such as *left* and *gave away* which are "cues to use subtraction" (p. 16). This strategy does not always guide students to choose the correct operation. Referring to Cawley, Fitzmaurice-Hayes, & Shaw (1988), Parmar and Cawley explain that "The use of the cue word is appropriate

only when the teacher wants to direct the child to computation routines without consideration for the meanings and organization of the words that comprise the problem" (p. 16). Cue words are a form of rote learning, where students are taught to memorize the procedure rather than reflect on and understand the process. Parmar and Cawley add that when teaching word problem skills to learning disabled students, a variety of methods should be incorporated into instruction. They believe that "four presentation options (say, write, display, and manipulate) are available to teachers and four response options (say, write, identify, and manipulate) are available to students. Any combination of these skills may be appropriate for individual students" (p. 18). For learning disabled students to find success with math word problems, teachers must allow for individual preferences.

Zentall and Ferkis (1993) believe that difficulty in reading is not the only factor that causes learning disabled students to falter with word problems. They point out that the math "curriculum is spiral. That is, multiple skills are introduced, and each year the same skills are re-examined, perhaps in greater depth...most students move on in the curriculum before mastering prior skills" (p. 13). Because they often have not had enough time to master basic skills, students with learning disabilities usually lack the knowledge necessary to solve word problems. Moreover, Zentall and Ferkis point out that the average class spends 70 to 90 percent of classroom time using math textbooks. Textbooks are very inefficient for students, especially those with learning disabilities because they "neglect the individual needs of students and focus primarily on computational skills, which are often practiced by the routine use of paper/pencil learning" (p. 14). Zentall and Ferkis refer to Kirby and Becker (1988) who discredit the use of textbooks, claiming that textbooks do not permit mathematical skills to be "practiced in a meaningful and fun fashion" (p. 14). Quoting Englemann et al. (1991), Zentall and Ferkis list several other

shortcomings of math textbooks:

> (a) concepts are introduced with little connection between ideas or topics;
> (b) examples may be presented, but possible strategies are typically not;
> (c) guided practice is often nonexistent;
> (d) structure is insufficient (i.e., consistent use of signals, such as title, previews, summaries, key words, text formatting, introductory vocabulary)
> (e) graphics may be unrelated to the text (p. 14).

The limitations which most math textbooks possess hinder the possible development of problem solving skills in learning disabled students.

Summary of the Literature

The literature suggests that a fully integrated curriculum is needed if students are to truly master problem-solving skills. In other words, during a math class, students must be given an opportunity to use manipulatives, orally discuss math concepts, write about math concepts, and represents concepts using both visual and dramatic arts. These different mediums will not be utilized to their full potential if they are only used as enrichment or time-filler activities. Rather, literature suggests that these mediums should be an integral part of the math curriculum. Textbook work should be only a small component of daily math. Instead of rote learning, the other activities listed give students an opportunity to extend their critical thinking skills. By creating an integrated mathematics curriculum, students become actively engaged in their learning and develop the strategies and critical thinking skills necessary for successful problem solving. Moreover, an integrated curriculum provides students with a wealth of strategies to work with. In this way, students are not trying to memorize one appropriate strategy for each type of story problem they come across. Rather, they are learning that there are many different solutions for a given problem, and they are given the freedom to choose one

which is most comfortable for them. Rebecca Z. Rich and Sylvia Blake (1994) believe that "when students are responsible for selecting the strategies they find efficient, given the demands of the task, they are more apt to become self-regulated learners" (271). In other words, and integrated curriculum helps students become independent workers capable of evaluating their own progress. Such a curriculum helps children become confident of their abilities as problem solvers and enables them to engage in critical thinking tasks without constantly seeking guidance from their teacher.

Chapter Three: Design of Project

Introduction

The purpose of this project is to develop problem solving strategies and critical thinking skills in third grade students. This project is a supplementary teacher's guide designed to be used in conjunction with the Addison-Wesley third grade math kit. This teacher's guide gives teachers an alternate method of presenting the questions found in the Problem of the Day Black-Line Masters. This method is an integration of manipulative use, writing, drama, and the visual arts.

Procedure

As a third grade teacher in the Federal Way School District, the author has noticed that many third grade students often struggles to develop problem solving strategies and critical thinking skills. The Addison-Wesley math series used by the author's school includes problem solving and critical thinking as one of its main components; yet the author feels that this part of the series needs to be supplemented. Using just the materials and guidelines supplied in the Addison-Wesley math kit, the author has observed that many students are not meeting the Federal Way School District's academic requirements in the stated content area. It is not realistic for the author to create a new math program because teachers at the author's school are required to use texts and materials selected by the administrator. The author's solution has been to create a teaching guide which will help teachers better utilize the Addison-Wesley kit. This guide pertains specifically to the Problem of the Day Black-Line Masters found in the Addison-Wesley kit. Through research, the author has found best practice accounts and studies which support the integration of math, manipulative use, writing, drama, and

the visual arts. It is believed that integrating these fields will promote the development of problem solving strategies and critical thinking skills in students.

Chapter Four: Project Study

Overview of the Project

This supplementary teacher's guide is a combination of instructions, descriptions, and sample lessons. For clarity, the author has selected one Problem of the Day from each chapter of the Addison-Wesley kit. Each selected problem has been used in a sample lesson. The lessons have a twofold purpose: First of all, these lessons can be taken from the guide and used by teachers in their classrooms. Secondly, they are samples which can guide teachers when they create their own lessons for the remaining questions in the math kit. There are a total of sixteen lesson plans in this teacher's guide.

Problem of the Day Teacher's Guide

Introduction

The following 16 sample lessons contain a collection of word problems found in your Problem of the Day Blackline Master workbook. This guide includes one word problem from each chapter of the textbook. These sample lessons can be used exactly as they are in your classroom. They can also be used as guidelines for the remaining word problems in the workbook.

These lesson plans have been designed to integrate writing, manipulative use, drama and drawing. Students will need a math journal, some sort of notebook designated for responding to specific topic questions and for recording whatever thoughts or feelings they have regarding the topic being explored.

For each lesson, always have manipulatives, writing and drawing materials

available for student use, and a surface such as a board or overhead projector available for group discussions. Each student will also need their math journal and a copy of the problem solving worksheet (Appendix A) during each lesson.

This guide comes with four evaluation rubrics. The Self-Evaluation Rubric (Appendix B) provides students with an opportunity to evaluate their own progress. This evaluation can be used for a moment of self-reflection at the end of each lesson, or it can be used less frequently. The self-evaluation was not designed to be graded. It is, however, a good tool for teachers to use to analyze students' progress and their feelings about their work. Like the self-evaluation rubric, the Journal Assessment Rubric (Appendix C) is designed to provide valuable feedback to the teacher. This rubric will help teachers determine how effective journal writing is for their students, and what learning processes are occurring throughout the problem-solving and journal writing experience.

The final two rubrics are designed to evaluate the student during the actual problem-solving lesson. The Numerical Problem Solving Rubric (Appendix D) will provide teachers with a score out of 15 which can be used in grade books to help determine a letter grade in mathematical problem-solving. The Anecdotal Problem Solving Rubric (Appendix E) gives teachers the option of basing their evaluation solely on comments and observations if they are not interested in letter grades. Teachers can select rubrics based on their own personal needs. It is not intended that all four of these rubrics are to be used for each lesson. Teacher may use as many of the rubrics as they feel are necessary to provide ample feedback of students' progress.

Lesson 1: Introductory Lesson

This first lesson contains three parts and will cover at least three math sessions. More than three sessions may be needed, depending on how quickly students master these three lessons.

A) The first challenge students face during problem solving is understanding the question being asked. Language, vocabulary, and lack of practice often limit students' abilities to decode a word problem and gain a full understanding of what they are being asked to do. Students need opportunities to practice reading a word problem and understanding what they are being asked. For the first two sessions of your math class, focus solely on comprehension. Give students word problem and have them rephrase the problems using their own words. Use the following prompts and discussion guides:

- Is there an easier way to ask this question?
- How would *you* ask this question?
- How can we make this word problem more clear?
- What is this word problem asking us?
- Can we ask this question another way?
- Put this word problem into your own words.

The following five word problems are sample questions which can be used during your discussions. You can also make up your own or pull word problems out of the textbook. Vary the levels of the practice questions. Students do not necessarily need to know how to solve the problems, they are just working on developing the comprehension skills necessary to decode word problems.

1. Carlos is starting up a basketball team. He needs 11 players. 16 people have asked to join his team. How many people cannot play on Carlos' team?
2. Ming Lee is going to the store. It takes him 15 minutes to walk there. If he leaves at 2:30, what time would he get to the store?
3. Ayanna needs 5 yards of fabric to make a dress. She already has 2 yards. How many more yards does she need?
4. Michael had 6 pages in his sticker book. He put 2 stickers on each page. How many stickers did he have?
5. Jenny and Jamal each had $5.00. Jenny spent $2.50 on candy and Jamal spent $1.75 on gum. If they put the rest of their money together, how much would they have left?

Vary the way students' ideas are shared. For some of the word problems, place students' ideas on an overhead projector or on the board so that students' can read one anothers' variations of the same problem. Organize small groups of 2 to 4 and allow students to work on rephrasing questions together. Give students opportunities to practice rephrasing questions on their own.

B) The next part of Lesson 1 involves helping students pull out the information they need to solve a problem. You can use the same questions from Part A. For each word problem, have students pull out the facts needed to solve the question.

Example:

Teacher- Let's look back at this word problem from our last math class

"Carlos is starting a basketball team. He needs 11 players. 16 people

have asked to join his team. How many people cannot play on his team?"

Teacher- Can anyone put this question into their own words?

Student- How many people will be left out.

Teacher- What facts do we know that will help us solve this problem

Student- Carlos only needs 11 people.

Student- 16 people want to be on his team.

Teacher- Are there any other facts we need to know to solve this question?

Student- No.

This is a good place to stop the discussion and move on to another sample question. At this stage, students do not need to solve the question. They are learning how to pull meaningful information out of a word problem before attempting to solve it. Like the activities in Part A, students should practice this as a class, in small groups and individually before moving on to Part C, which involves choosing the right strategy to solve a problem.

C) Before class preparations: Make an overhead copy of the worksheet found in Appendix A. Make double-sided copies of Appendix A for the entire class (you may want to make 2 sheets for each student). Using a photocopier, blow up the strategy wall chart found in Appendix F.

Use one of the word problems used in both Parts A and B to illustrate how this worksheet is to be used. As a class, fill in the first two sections of the worksheet (*What is the question? What facts will help me solve this question?)* using the information from previous classes (see Appendix G as an example). For the section titled *My strategy*, draw

students' attention to the strategy wall chart. Review this chart with the class, making sure that students know where classroom manipulatives are kept. (During problem solving, manipulatives, writing and drawing materials should always be easily accessible for students.) With your class, brainstorm how these various strategies can be applied to a word problem, writing students' ideas on the board or overhead projector.

Example:

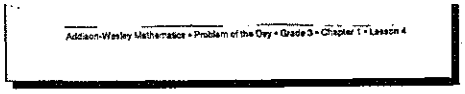
"Carlos is starting a basketball team. He needs 11 players. 16 people have asked to join his team. How many people cannot play on his team?"

1. *Manipulatives-* Give each student counters to solve this problem. Discuss how they used the counters to solve this problem. Students can work in groups of two for this activity.
2. *Act it out-* Select 17 students to act out this problem. Have one student, representing Carlos, pick 11 students out of the 16 remaining. Students can then see how many have been left behind.
3. *Draw a picture-* Give students drawing materials and have them illustrate a solution to the problem. Then allow students to post their drawings for others to see. Students will notice that their drawings are different from one another: One student may draw a picture of a boy selecting 11 people from a group of 16, another may simple draw 16 "sticks" and cross out 11.
4. *Equation-* 16-11=5

Pass out copies of the problem solving worksheet. Have students complete the worksheet, using whichever strategy they prefer in the section titled *My strategy.* Have students work

through two more word problems from sections A and B with a partner.

Lesson 2



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Put students into groups of three. Give each group several small boxes/containers and an assortment of counters to represent worms. Each student is to play the role of David, Marc or Dawn and act out the word problem in their groups. Complete the problem solving worksheet as a class or in small groups depending on student need and ability. Journal Topic: How did acting out the word problem with your group help you? How could you solve this problem without acting it out?

Lesson 3

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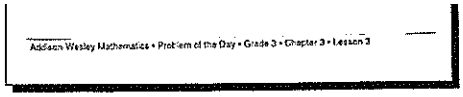
Arrange students into groups of four. Give students a choice of using acting, drawing or a combination of the two to solve the problem. Have students complete the problem solving worksheet with their group members.

Journal Topic: Why did you have crackers left over? Is there a way to share the crackers so that there wouldn't be any left over?

Lesson 4



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Supply each student with a second-hand clock manipulative. Have students solve the problem on their own, complete the worksheet and then explain their solution to a partner.

Journal Topic: How could you solve this problem if you didn't have a clock?

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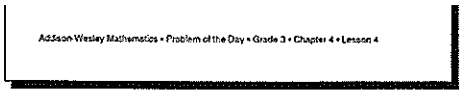
Lesson 5



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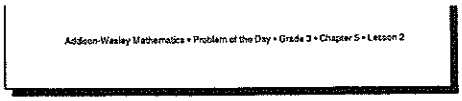
Discuss multi-step word problems. Tell students this problem requires at least 2 different operations in order for it to be solved. Ask students to discuss with their partners what two steps need to be taken (ie: *What two things do you need to do to solve this problem?*). After students have finished their group discussions, conduct a class brainstorm where all ideas are listed on the board or overhead projector. Once everyone has had a chance to share their ideas, supply the correct answer: Students must find out how much money Leon has and then figure out how many pennies make up that amount. Supply each pair of students with an assortment of monetary manipulatives. Have partners solve the problem and complete their problem solving worksheet.

Journal Topic: How could this question be solved without figuring out how much money

Leon has all together.

Lesson 6



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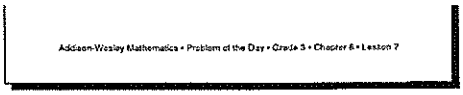
Allow students to work independently, completing the problem solving worksheet and using whichever strategy they are the most comfortable with the answer the question. Once students have finished, place them in groups of three where they are to share the strategies they used to reach their answers. Students are to also discuss how each response differed from one another and come to a consensus of one correct answer for the group (not a single strategy, but a single answer). Lead a class discussion to debrief once all groups have finished.

Journal Topic: Explain why and how members of your group had different answers than

you did. Do you think there is one strategy that is the best way to answer this question? Why or why not.

Lesson 7



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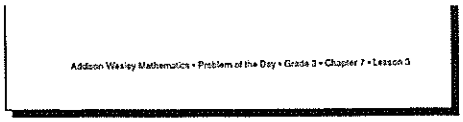
Give students the choice of either working alone or with a partner. Have students draw a picto-graph to solve the problem. Display graphs and discuss how the graphs differ from one another, yet the answers are still the same (ie: there are many ways to reach the same solution, even if the same strategy is being used).

Journal Topic: Choose a graph on the display board that is different from yours. Explain why this graph has the same answer as yours, even though they are different.

Lesson 8



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Gives groups of swatches of fabric in two different colors (students should have at least two swatches of each color). Designate one color to represent felt and the other to represent velvet. Make it clear to student that one swatch represents one yard of fabric. Using markers, have students label each swatch the appropriate price ("felt" swatches should be labeled $1.79 and "velvet" swatches should be labeled $4.66), then let teams solve the problem and complete the problem solving worksheet on their own.

Journal Topic: If you did not have fabric, what would you do to solve this question?

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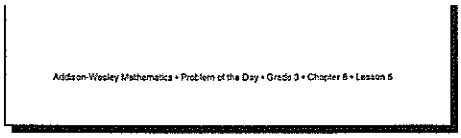
Lesson 9



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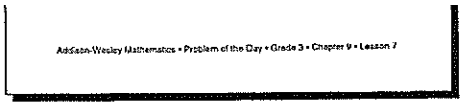
Before beginning this word problem, a class discussion must be held. Students need to become aware of aspects of a word problem that they are unfamiliar with and find ways to become familiar with them. Many students read a word problem and immediately say the do not understand it when there is just one little detail that they need help with. Once this detail is clarified, many students can then move on to complete the problem successfully. The challenge is helping students pick out this one detail rather than having them feel as if the entire problem is too difficult for them to complete. Read this problem over with students. Ask students if there is anything they do not understand in this problem. Keep suggestions flowing until someone asks what a tandem bike is (a bike that seats two people). Make sure students put either the definition of a tandem bike or a

picture of it under the *What I know* section of their worksheets.

Journal Topic: Explain what was tricky about this question. If we did not talk this question over as a class, what could you have done to help you solve this problem?

Lesson 10



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For this word problem, complete the *What I know* section of the problem solving worksheet as a class. Have students work on solving the problem either alone or with a partner. Once students have completed their worksheets, group teams together forming groups of four. Have group members share their strategies and answers and then come to a consensus for a correct answer and at least two strategies for getting this answer. Journal Topic: How did it help you to share your work with a group? Explain how different strategies can reach the same answer.

Lesson 11

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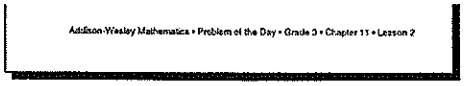
As in Lesson 9, the focus here is helping students to pick out key elements of the word problem which they may be unfamiliar with. Students must know the definition of a polygon before they are able to solve this problem. Depending on how far you have progressed in Chapter 10 of your textbook, students may or may not know the meaning of this term. As a class, review the definition of the term *polygon* and have students write a meaning for this word under the *What I know* section of their worksheets. As a class, brainstorm the other criteria which must be placed in this section:

- Each shape must have sides that equal 24 feet in length.
- Each shape must be a polygon (a shape that is fully closed)
- As a class, form a consensus as to how many different shapes each person must create.

Once all students have completed their polygons, allow students to draw one of their shapes on a class sized sheet of butcher paper so that others can examine how so many different shape hold the same criteria (they are all polygons totaling 24 feet in length).

Lesson 12



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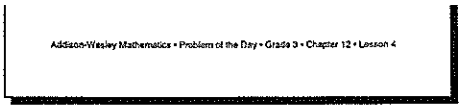
Have students draw, color and cut out 6 eggs. Using manipulatives to represent students, have teams of 2 solve this problem and complete their problem solving worksheet.

Journal Topic: Pretend you are helping someone solve this problem. Explain, using only words, what you and your partner did to solve this question.

Lesson 13



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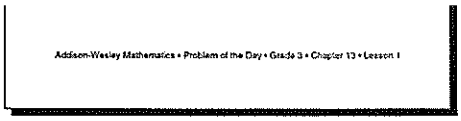
Give pairs of students a collection of counters and two paper cups. As a class, discuss as a class how many counters each group must begin with (68). Allow students to complete the word problems with their partners.

Journal Topic: Explain how you could use subtraction to solve this problem. Why would subtraction work?

Lesson 14



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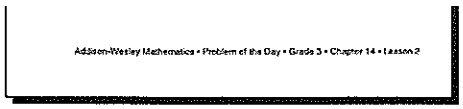
As a class, discuss and complete the first two sections of the problem solving worksheet (*What's the question? What facts will help me solve this question?*). It is helpful if students understand the concept of a tip before working to solve this problem. Have students complete the remainder of the worksheet on independently. Students are to use any strategy of their choice. Once students have finished, arrange them into groups of 3 to 4. Have students share their answers and strategies with one another, explaining why they feel their answer is correct.

Journal Topic: How were your answers and strategies different from those of your group members? What do you think is the correct answer? Explain why.

Lesson 15



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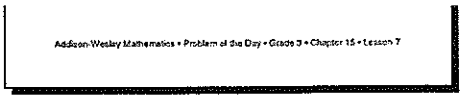
Focus here on making sure that students fully understand what they are being asked to do. Begin a class discussion with prompts such as, "What do we have to find out?". Keep the discussion moving until students understand that they have to figure out what half of 76 is. When students have reached this point, allow them to solve the problem on their own, using a strategy of their choice.

Journal Topic: Explain what strategy you used to solve this problem and why you chose it.

Lesson 16



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As in Lesson 15, the focus must be on helping students understand what the question is asking them to do. Students may get so caught up with recreating Zachary's bulletin board that they will loose sight of what the true question is. Do not let students proceed until they understand that they must make different combinations of 24 books using the titles Fiction, Science, Mystery, and Sports.

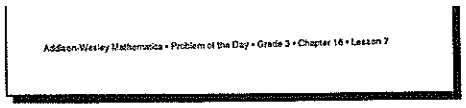
Example:	6 fiction books	Or:	7 fiction books
	6 science books		3 science books
	6 mystery books		10 mystery books
	6 sports books		4 sports books
	24 books total		24 books total

As a class, brainstorm and develop a few combinations, then let students create

combinations on their own. Come to an agreement as a class as to how many combinations each child must create. As students finish, allow them to write one combination on a class-sized sheet of butcher paper for all to see.

Journal Topic: Explain why this problem was confusing when we first read it.

Lesson 17



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As a class, discuss what this question is asking students to do. Complete the *What's the question* section of the problem solving worksheet together. Give teams of 2 an assortment of monetary manipulatives and tell them they are going to act out this word problem. Hold the following dialogue with students:

Teacher: How much money were Eveleen and Ginger paid?

Students: $3.75 an hour.

Teacher: How many hours did they work?

Students: Three hours.

Have students figure out count out $3.75 three times and figure out how much money that is all together.

Teacher: How could we use multiplication to solve this problem?

Allow students to work this question out on their own with their partners.

Teacher: Have a look at your problem solving worksheet. What was our original question?

Students: How much money did each girl get.

Teacher: Have we answered our question?

Students: No.

Discuss that we now know how much money Eveleen and Ginger earned together, and that they must now divide this money evenly between the two girls. Allow students to solve the remainder of this problem with their partners using any strategy of their choice.

Journal Topic: We worked on this problem for quite a while. Is there a faster way to solve this problem? Explain.

Chapter Five: Summary and Recommendations

Summary

This project was created out of a need the author discovered while working in an elementary school. Because of the stressed importance of the WASL exam (Washington Assessment of Student Learning), problem solving has become one of the primary focuses in the author's school. The WASL consists of a math section which requires students to solve complex word problems. As the expectations for students rise and change, teachers are expected to be able to help students meet these new academic requirements successfully. However, the materials teachers have been given to work with students have not kept up with new state testing and expectations. The teacher's guide created in Chapter 4 will hopefully show teachers how they can use the math materials sitting in their classrooms to help students meet the academic requirements set by the Federal Way School District, and also how to help students meet the requirements set by the Washington Assessment of Student Learning.

The author's research, as discussed in Chapter 2 of this project, suggests that writing, drama, drawing and manipulative use can be essential components of a problem solving lesson. The goal of the teacher's guide created in Chapter 4 was to show teachers that these elements can easily be integrated into a math lesson and do not require a lot of extra time, materials, space or planning. The research discussed Chapter 2 consisted primarily of "best case practices". In other words, Chapter 2 contains articles written by teachers describing techniques which have worked successfully in their classrooms. This is important when considering whether or not teachers may actually use the teacher's

guide in Chapter 4. The author feels that teachers will be more likely to use something when they hear that the research is based on the successfully practices of others, rather than the hypothetical theories of someone who does not spend the majority of their time in a classroom.

Recommendations

The author's primary recommendation is that teachers take this project and use its principles in their math classes. Teachers of all grade levels can use this guide. The sample lessons can be used as examples which teachers can use to create their own lessons appropriate for their grade levels.

Further study in the area of problem solving development is needed. The author had difficulties finding research or best-case practices which pertained specifically to minority and ESL students and their academic developments in this area. Struggles with the English language or, as is the case with many minorities, using and comprehending the language slightly differently from its traditional forms may have an effect on how students decode and attempt to solve word problems.

Appendix A

Name _____ *Date* _____

My Problem Solving Worksheet

What's the question?	*What facts will help me solve this question?*
My strategy: *My answer is* _____	

Appendix B

How Did I Do?

Student's Name _____

Word Problem _____

	Yes	Not Sure	No
I understood the question.			
I was able to pick all the helpful facts out of the word problem.			
I picked a strategy the helped me solve this question.			
My answer was right.			
I can explain how I got my answer.			
I enjoyed this assignment.			
I worked well with my partners.			

I have something else to say! _____

_____

Appendix C

Journal Evaluation

Student's Name _____

Word Problem _____

Concept being explored _____

	Yes	Slightly	No
Does the student answer the question?			
Does the student's writing reveal a basic understanding of the concept being explored?			
Does the student's response reveal an advanced level of understanding?			
Does the student's response show that thought and reflection have gone into this journal entry?			

Additional Comments: _____

_____

_____

_____

Appendix D

Problem Solving Rubric

Student's Name _____

Word Problem _____

Concept being explored _____

	Struggled	Almost There	Mastery Level
student understands what the question is asking	**1**	**2**	**3**
student is able to pick out the useful elements of the word problem	**1**	**2**	**3**
student is able to select a logical strategy to solve this problem	**1**	**2**	**3**
student is arrives at a correct answer for this problem	**1**	**2**	**3**
student is able to explain their answer clearly	**1**	**2**	**3**
Total Points			

Total Score /15

Comments: _____

_____

_____

_____

_____

Appendix E

Problem Solving Rubric

Student's Name _____

Word Problem _____

Concept being explored _____

	Struggled	Almost There	Mastery Level
student understands what the question is asking			
student is able to pick out the useful elements of the word problem			
student is able to select a logical strategy to solve this problem			
student is arrives at a correct answer for this problem			
student is able to explain their answer clearly			

Comments: _____

_____

_____

_____

Appendix F

*What **strategies** can I use to solve this problem?*

- *Use **manipulatives** or **counters***
- *Act it out*
- *Draw a picture*
- *Write an **equation***
- *Make a **chart** or **graph***

Appendix G

Name _____ *Date* _____

My Problem Solving Worksheet

What's the question?	*What facts will help me solve this question?*
How many people will be left out.	Carlos only needs 11 people. 16 people want to be on his team.
My Strategy: *My answer is* _____	

Appendix H

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ISBN: 0-201-44893-9
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Copyright Dates: 1995, 1993
Requested Pages: 4, 13, 24, 34, 45, 64, 70, 82, 92, 103, 109, 121, 125, 136, 149, 164
Intended Use: I am a third grade teacher currently completing my Master's Degree in Education. My thesis project is a supplementary teacher's guide which shows teachers in my school how to adequately use the Addison-Wesley Problem of the Day Blackline Masters book in an integrated curriculum. We are currently using this book in our school. I would like to place copies of the requested pages in my thesis project along with sample lessons which I've created to show teachers how to use an integration of writing, manipulative use, drama and drawing when using the Addison-Wesley Blackline Masters.

Nwaynna B. Stewart

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