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Comparison of East Asian and Western Culture in Teaching Mathematics: A Model of Elementary School Mathematics Curriculum

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COMPARISON OF EAST ASIAN AND WESTERN CULTURE IN TEACHING MATHEMATICS: A MODEL OF ELEMENTARY SCHOOL MATHEMATICS CURRICULUM

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by

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ABSTRACT

COMPARISON OF EAST ASIAN AND WESTERN CULTURE
IN TEACHING MATHEMATICS:
A MODEL OF ELEMENTARY SCHOOL
MATHEMATICS CURRICULUM

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The purpose of this project was to compare cross-cultural mathematics teaching in the elementary schools in East Asian and Western countries, particularly focused on Taiwan and the United States. Another purpose was to design and develop a common mathematics curriculum program for elementary schools to use in both environments. To accomplish this purpose, a review and comparison of current research and literature regarding current curriculum and teaching practice of mathematics in Taiwan and the United States was conducted. Additionally, related information from selected sources was obtained and analyzed.

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CHAPTER 1

BACKGROUND OF THE PROJECT

Introduction

> Yet it is equally important to recognize that standards and assessments, though necessary, are not enough. What must be done now is to find ways of providing students with the learning opportunities they need to reach the new standards. Making higher standards a reality for students will require more than just the status quo inside our nation's classrooms; curriculum, assessments, and—above all—teaching must improve dramatically. In our view, teaching is the next frontier in the continuing struggle to improve schools. Standards set the course, and assessments provide the benchmarks, but it is teaching that must be improved to push us along the path to success (Stigler & Hiebert, 1999, p. 2).

In the above statement, Stigler and Hiebert have pointed out that the quality of teaching must be primary and central in efforts to improve students' learning in mathematics. In addition, different instructional materials, teaching methods, and teaching styles are also played as significant influences on students' learning outcomes. Further, it is implied that effective teaching and a coherent curriculum would assist students to achieve higher standards and higher performances in mathematics.

Slavin (1996) concluded that standards and accountability can provide some motivation and direction for front-line educators, but ultimately they need better methods, better materials, and better professional development. As such, educational reform strategies should not only target the concepts of raising the mathematics standard, reducing class-size, or adding new techniques and new tools in the classroom but focus on implementing and improving solid teaching strategies in the United States. Slavin (1996) also said, "student achievement cannot change unless America's teachers use markedly more effective instructional methods" (p. 4).

Perhaps, cross-cultural comparative studies of teaching mathematics have the potential to generate insight notions of discovering characteristics of each culture that people fail to notice because they are so familiar with them. Stevenson and Stigler (1992) were doing research on contrasting and comparing the elementary mathematics education systems between Asia and the United States. They explained how instruction materials, mathematics curriculum, and whole class teaching might have a significant influence on teaching and students' learning. Stevenson and Stigler (1992) further indicated:

> One way to think of a lesson is by using the analogy of a story. A good story is highly organized; it has a beginning, a middle, and an end, and it follows a protagonist who meets challenges and resolves problems that arise along the way. Above all, a good story engages the reader's interest

> in a series of interconnected events, each of which is best understood in the context of the events that precede and follow it.
>
> In Asia, instruction is guided by this concept of a lesson. The curricula include coherent lessons, each carefully designed to fill a forty-to fifty-minute class period with sustained attention to the development of some concept or skill. Like a good story, the lesson has an introduction, a conclusion, and a consistent theme. (p. 177)

Based on the current emphasis on educational reform and Washington State Essential Academic Learning Requirements (EALRs), all students from each grade need a deep understanding of mathematics; as a result, learning cross-cultural differences in teaching mathematics would improve students' performance in mathematics. There is a strong cause and effect relationship between teaching and learning.

Purpose of the Project

The purpose of this project was to compare cross-cultural mathematics teaching in the elementary schools in East Asian and Western countries, particularly focused on Taiwan and the United States. Another purpose of this project was to design and develop a common mathematics curriculum for elementary schools to use in both environments. As such, school administrators would have clear goals and clear directions to provide students with better learning opportunities and a learning environment that would allow students to

achieve the new standards of the state test, the Washington Assessment of Student Learning (WASL). For teachers, they would have a better idea of how to improve and polish their teaching skills in the classroom.

To accomplish this purpose, a review and comparison of current research and literature regarding current curriculum and teaching practice of mathematics in Taiwan and the United States was conducted. Additionally, related information from selected sources was obtained and analyzed.

Limitations of the Project

For the purposes of this project, it was necessary to establish the following limitations:

1. Research: The preponderance of research and literature reviewed was limited to the elementary mathematics education system in the regions of East Asia and Western countries. The regions in East Asian countries are Hong Kong, Japan, Taiwan, and the Peoples Republic of China. The regions in Western countries are Australia, England, Germany, and the United States.
2. Scope: Compare cross-cultural mathematics teaching in the elementary schools in East Asia and in Western countries. The model of coherent mathematics curriculum program was designed for elementary school to use.

3. Target Population: The students from first grade through sixth grade in East Asian and Western countries.

Definition of Terms

Significant terms used in the context of this project have been identified as follows:

1. Algebra: Relationships among quantities, including functions, ways of representing mathematics relationships, and the analysis of change (National Council of Teachers of Mathematics [NCTM], 2000, p. 37).
2. Assessment: Assessment should support the learning of important mathematics and furnish useful information to both teachers and students (NCTM, 2000, p. 11).
3. Benchmarks: The performances used to measure student progress at different points in time or at different grade levels (Office of Superintendent of Public Instruction [OSPI]).
4. Classroom organization: A multifaceted dimension of teaching that includes the content, methods, and values that infuse the classroom environment (Johnson, Dupuis, Musial, Hall, and Gollnick, 2002, p. 439).
5. Coherent curriculum: One that holds together, that makes sense as a whole; and its parts, whatever they are, are unified and connected by that sense of the whole (Beane, 1995, p. 3).

6. Content standards: Standards that specify learning outcomes in a subject or discipline (Johnson et al., 2002, p. 531).
7. Curriculum: A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades (NCTM, 2000, p. 11).
8. Geometry: The study of shapes and structures, including spatial visualization (NCTM, 2000, p. 41).
9. Instructional materials: The discrete physical components or blocks of curriculum including, for example, textbooks, software, kits, and teacher's guides (National Research Council [NRC], 1999, p. 1).
10. Learning: Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge (NCTM, 2000, p. 11).
11. Mathematics: A language and science of patterns. This created a means for describing the world in which we live, using a universal language for communication. It provides a mode of inquiry that reveals fundamental understandings about order in our world (OSPI, 2001, September).
12. Measurement: The assignment of a numerical value to an attribute of an object (NCTM, 2000, p. 44).
13. Probability: A way to measure the uncertainty from statistics. It provides the likelihood of an event occurring (Burns, 1992).

14. Repetitive learning: Continuous practice with increasing variation (Leung, 2000, p. 5).
15. Standards: The specific academic skills and knowledge students will be required to meet in the classroom (OSPI).
16. Statistics: The science or study of data. The study of statistics requires collecting, sorting, representing, analyzing, and interpreting information (Burns, 1992).
17. Student-centered instruction: Students exercise a substantial degree of responsibility for what is taught, how it is learned, and for movement within the classroom (Cuban, 1993, p. 7).
18. Teacher-centered instruction: A teacher controls what is taught, when, and under what conditions within a classroom (Cuban, 1993, p. 6).
18. Teaching: Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well (NCTM, 2000, p. 11).

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

The review of research and literature summarized in Chapter 2 has been organized to address the following topics:

1. The Importance of Mathematics in Today's and Tomorrow's World
2. Mathematics Educational Systems in East Asian and Western Cultures

   East Asian Cultures

   - Curriculum
   - Instructional Materials

   Western Cultures

   - Curriculum
   - Instructional Materials
3. Systematic of Teaching Mathematics in East Asian and Western Cultures

   East Asian Cultures

   - Teaching Methods and Patterns

   Western Cultures

   - Teaching Methods and Patterns
4. Assessment

5. Reformation of the Mathematics Curriculum in Taiwan
6. Essential Academic Learning Requirements of Washington State
7. Summary

The research addressed in Chapter 2 was identified through Educational Resources Information Center (ERIC) computer search and Internet computer searches.

The Importance of Mathematics in Today's and Tomorrow's World

In today's increasingly challenging and technologically innovative world, there are very few commercial, industrial, and scientific endeavors that do not depend on the mathematics. Practicing good skills in mathematics and applying better knowledge of mathematics are the major components students should focus on. According to the National Research Council (1989), mathematics is the key to opportunity. No longer just the language of science, mathematics now contributed in direct and fundamental ways to business, finance, health, and defense. For students, it opens doors to careers. For citizens, it enables informed decisions. For nations, it provides knowledge to compete in a technological economy.

Zaslavsky (1994) indicated that everyone in today's world needed skills in mathematics. Even though not every job requires special mathematical skills, it helps to have some facility with math and some confidence in one's ability to handle problems as they arise. Zaslavsky further stated the following:

> Increasingly the jobs in tomorrow's economy will require a knowledge of mathematics. New technologies will call for the ability to apply mathematics and science in practical ways, and rapid changes will demand that workers learn new skills throughout their lives. (pp. 28-29)

Steen (1989) also said, "Mathematics is the key to opportunity for these [high technology] jobs" (p. 18). Steen offered another interpretation of the importance of teaching and learning mathematics in today's and tomorrow's world as following:

> Today's students will live and work in the twenty-first century, in an era dominated by computers, by world-wide communication, and by a global economy. Jobs that contribute to this economy will require workers who are prepared to absorb new ideas, to perceive patterns, and to solve unconventional problems. (p. 18)

Problem-solving abilities were at the heart of an inquiry into the effect of evaluating mathematical skills in the American and global economies. The Committee for Economic Development (1995) described that "A workforce with inadequate mathematics and science skills not only forfeits career opportunities but dilutes the competitive productivity of America's industries in the global marketplace" (p. 2).

The U.S. economy has shifted from a manufacturing goods economy to more service and information oriented industries. Britton, Huntley, Jacobs, and Weinberg (1999) have concluded that occupations today have largely migrated to

service and information industries. Such industries require an entirely different set of knowledge and skills, including an understanding of mathematics and science, problem-solving abilities, proficient communication skills, and independent initiative combined with the ability to work collaboratively.

Stigler and Hiebert (1999) stated that the Third International Mathematics and Science Study (TIMSS) has generated a wave of concern about students' achievements in mathematics, and it has also collected a wealth of information about the different levels of students' performances in different countries. Through cross-cultural comparative studies of students' mathematics performances, Rowan and Bourne (2001) indicated that American students performed less successfully in mathematics than students educated in other countries, many of which were less wealthy and less technologically advanced than the United States.

In order to prepare today's students to access tomorrow's world, the goals of teaching mathematics must be appropriate for the demands of a global economy in the information age. The National Council of Teachers of Mathematics (2000) identified four broad goals required to meet students' mathematical needs of the 21st century:

1. Mathematics for life. Knowing mathematics can be personally satisfying and empowering. The underpinnings of everyday life are increasingly mathematical and technological.

2. Mathematics as a part of cultural heritage. Mathematics is one of the greatest cultural and intellectual achievements of humankind, and citizens should develop an appreciation and understanding of that achievement, including its aesthetic and even recreational aspects.
3. Mathematics for the workplace. Just as the level of mathematics needed for intelligent citizenship has increased dramatically, so too has the level of mathematical thinking and problem solving needed in the workplace, in professional areas ranging from health care to graphic design.
4. Mathematics for the scientific and technical community. Although all careers require a foundation of mathematical knowledge, some are mathematics intensive. More students must pursue an educational path that will prepare them for lifelong work as mathematicians, statisticians, engineers, and scientists. (p. 4)

Mathematics Educational Systems in East Asian and Western Cultures

Graf and Leung (2000) pointed out that the frameworks of the mathematics educational systems in East Asian and Western countries are very different in the mathematics educational policy, in the organization of mathematics curriculum, and in the approaches to assessment of the students' achievements.

Stigler, Lee, and Stevenson (1987) indicated "Educational policy is more centralized in Taiwan and Japan than in the United States" (p. 1273). From that centralized policy, Menon (2000) concluded that Singapore's success on the TIMSS tests is based on its centralized curriculum. In *Principles and Standards for School Mathematics*, NCTM (2000) stated:

> A school mathematics curriculum is a strong determinant of what students have an opportunity to learn and what they do learn. In a coherent curriculum, mathematical ideas are linked to and build on one another so that students' understanding and knowledge deepens and their ability to apply mathematics expands. (p. 14)

Li (2000) also claimed that different mathematics curricula showed different topic sequences and arrangements in the instructional materials. Garner (1992) argued that "textbooks serve as critical vehicles for knowledge acquisition in school" (p. 53). Stigler and Hiebert (1999) pointed out how textbook content would influence student learning as follows:

> If the content is rich and challenging, it is more likely that students have the opportunity to learn more mathematics and to learn it more deeply. If the content is fragmented and ordinary, students have less chance of learning important mathematics. (pp. 56-57)

East Asian Cultures

Curriculum.

In many of the Ministries of Education of East Asian countries, a coherent national mathematics curriculum has been established for each grade. It dictated that different topics be taught at different times of the year across the entire nation. First and foremost, the mathematics curriculum in East Asia is coherent and its contents standard leading to an integrated approach to topics from the earliest grades, with several areas of mathematics appearing at each grade level and developing connections to one another. For example, as Stevenson and Stigler (1992) have shown:

> The ministries of education in both Taiwan and Japan publish volumes describing the course of study in elementary schools. The general objectives of instruction for each subject at each grade are described in three or four paragraphs, followed by detailed descriptions of the content of the curriculum. (p. 136)

Leung (2000) mentioned that in East Asian countries, the traditional mathematics curriculum content focused on acquiring the body of knowledge. In the face of the 21st century, the educational reform trend in Western countries was focused more on the process of doing mathematics instead of learning the mathematics content itself. By contrast, the mathematics curriculum in East Asia has emphasized both the content and the process. For example, China's mathematics curriculum is emphasizing two basics—basic knowledge and basic

skills. In fact, East Asia educations believed that the content was fundamental and without it there was nothing for the process to be applied to in the mathematics curriculum.

A review of research and literature illustrated that the contents of elementary mathematics curriculum across East Asia are very similar. For instance, the content of elementary mathematics in Japan is divided into the following four categories: (1) numbers and computation, (2) quantities and measurements, (3) geometric figures, and (4) numerical relationships (Schmidt, W. H., Jorde, D., Cogan, L. S., Barrier, E., Gonzalo, I., Moser, U., et al., 1996, p. 151).

In another case, the content of the elementary mathematics in Hong Kong is divided into five learning dimensions: (1) number, (2) measures, (3) algebra, (4) shape and space, and (5) data handling (Mok and Morris, 2001, p. 458). The curriculum is structured around an increasingly specific hierarchy of learning targets.

Instructional Materials.

Past research (Stevenson & Stigler, 1992; Watanabe, 2001; Mayer, Sims & Tajika, 1995; Schmidt et al., 1996) has shown that consistent instructional material contents played a very important role in the success of the East Asian system. For teachers, it provides a blueprint for content coverage and instructional sequence. For students, it helps to progress their learning and knowledge skills. For example, Schmidt et al. revealed a case study in Japan:

> All textbooks are approved by the Ministry of Education. Textbook companies publish a teacher's manual that provides detailed teaching plans and exercises for students. In mathematics, teachers often ask students to purchase one or two drill and practice workbooks which are used in class and at home. Main instructional resources used in classrooms are textbooks, supplementary materials, hand-outs made by teachers, manipulatives, etc. The use of manipulatives is commonly observed in elementary mathematics classes. (p. 152)

Regarding the results, Asian countries have done very well in TIMSS tests. Valverde and Schmidt (1997-1998) concluded that Asian countries' textbooks have fundamental content and specific topics to cover in each grade. The framework textbook series was built from one unit to the next; therefore, students have prior fundamental knowledge for each concept before they are promoted to the next grade.

Stevenson and Stigler (1992) stated Asian textbooks are slim, inexpensively produced paperbacks. Separate volumes, seldom containing more than one hundred pages, cover each semester's work in each subject. Asian textbooks are developed on the assumption that knowledge should be cumulative from semester to semester.

Western Cultures

Curriculum.

Schmidt, McKnight, and Raizen (1997) concluded most of the mathematics and science curricula in the United States have lacked coherence and focus, and that has caused some researchers associated with TIMSS to characterize the typical curriculum in the United States as a "mile wide and an inch deep" (p. 2). Furthermore, a recent curricula analysis from the Third International Mathematics and Science Study found:

> U.S. mathematics and science curricula reflect juxtaposed goals competing for the same limited resources of time and attention. Our official mathematics and science curriculum statements have no central focus or strategic ideas or approaches to what should be learned in mathematics and the sciences. (U.S. National Research Center for the Third International Mathematics and Science Study, 1996, p. 2)

Such lack of focus in the American curriculum has influenced instruction and the achievement of students in TIMSS tests.

In addition, Stevenson and Stigler (1992) explained the results of such fragmented curriculum as the following:

> The United States does not have a national curriculum. Every state, and at times every school district within a state, is responsible for devising its own curriculum. Some argue...but the lack of a national curriculum has negative consequences. Enormous diversity in what is taught in the

> nation's schools and the fact that not all children have access to a basic core of knowledge and skills means that large numbers of young American cannot compete for future employment or participate fully as citizens. (p. 137)

Instructional Materials.

The TIMSS results clearly showed U.S. mathematics textbooks included almost any topic because the textbooks maintain traditional contents but still included the new contents set out in reform efforts in mathematics education. Consequently, teachers attempted to cover a large number of topics per grades but few taught in depth compared to most TIMSS countries (McKnight and Schmidt, 1998).

In contrast to those in East Asia, the contents of instructional materials in Western countries are not consistent or standard. Particularly in the United States, as Stevenson and Stigler (1992) mentioned, the content of the textbooks sometimes differs widely; the adoption of a new series is often a source of much controversy and wrangling by teachers, school boards, and state government. American textbooks are thick, hard-cover volumes covering a whole year's work. In addition, American textbooks are not developed on the assumption that knowledge should be cumulative from school year to school year. The textbooks follow what is often described as a spiral curriculum. At each grade level the textbooks present materials related to many different topics, and they repeat the discussion with some elaboration at later grades.

According to the National Research Council report (as cited in Tyson, 1997), publishers of mathematics and science instructional materials at all levels often attempt to cover all possible content in single products—primarily textbooks—in order to meet the requirements of as many districts and states as possible. The result is a smattering of all possible concepts and skills so that each state or district can find the topics required by its syllabus or standards. A well-developed instructional material would help student learning.

Systematic of Teaching Mathematics in East Asian and Western Cultures

Several researchers have exhibited mounting interest in the comparison of the practice of teaching in different counties for the last two decades (e.g., Leung, 1995; Schmidt, et al. 1996; Stevenson & Stigler, 1992; Stigler & Hiebert, 1999). In those comparisons, researchers have generally concluded that differences in the practice of teaching in classrooms in different countries, particularly in East Asian and Western countries, were both substantial and striking. The differences across countries dwarfed the differences of the ways of teaching within the same country.

In response to systematic teaching of mathematics, Aldridge and Fraser (2000) and Graf and Leung (2000) indicated that the teacher is one of the most crucial elements in the implementation of an effective system of teaching mathematics. Leung (1995) mentioned that the classroom organization context in East Asia is very distinct from that of Western countries in its setting, facilities,

and structure. During his comparative observation study in Beijing, Hong Kong, and London, Leung (1995) pointed out the most obvious differences were the number of students in each class and the procedure of conducting the class period.

East Asian Cultures

Teaching Methods and Patterns.

The structure of teaching styles in East Asia is whole class teaching, teacher-centered, and subject-mattered through kindergarten up to grade 12. This teacher-centered approach implies that the teacher is an expert or a scholar in East Asia. Leung (2000) concluded that "Expertise in pedagogy is important, but more important is a good grasp of the subject matter" (p. 7). Recent studies have shown that actually without a thorough understanding of the knowledge, it is not possible to invoke the appropriate pedagogy (Ma, 1999).

Stevenson and Stigler (1992) indicated the goal of mathematics instruction practiced in East Asia as follows:

> One goal of Asian teachers is to have children learn that there are many different methods for solving problems, presenting a single method in such full detail would limit the likelihood that children would come up with alternative solutions. A common technique used by Asian teachers in mathematics classes is to have children present as many different

solutions to a problem as possible, and then to have the class discuss which methods are most efficient. (p. 141)

According to Stevenson and Lee (1995), organizing the classroom into small groups would limit each student's benefit from the presence of the teacher, because the teacher must move from group to group throughout the class period. This meant that each group would only receive a very limited amount of the teacher's time in conducting the content of the curriculum. However, with effective management of whole class instruction, all children would receive the same amount of instruction during every lesson. For example, Japanese elementary school teachers presented each topic thoroughly and systematically so that all students are given adequate opportunity to master the material. Typically in East Asia, teachers usually reviewed the previous mathematics lesson in the beginning of the class period, then followed up in a coherent sequence by introducing new contents of the mathematics curriculum. At the end of period, teachers would conclude with the connection of previous topics.

Western Cultures

Teaching Methods and Patterns.

Due to educational reform in Western countries, the structure of teaching styles is tending toward small class size, student-centered teaching, and cooperative learning. Teachers mostly designed lessons oriented toward real-life problem solving rather than rote memorizing. According to Slavin (1995),

cooperative learning has typically referred to a variety of teaching methods in which students work in small groups to help one another to learn academic content. In cooperative classrooms, students are expected to help each other, to discuss and argue with each other, and to assess each other's current knowledge and fill in gaps in each other's understanding.

In contrast to East Asia, students in Western countries usually worked in a small group and spent more time on their own than they did participating in an activity led by the teacher in the western countries. Ma (1999) stated that American children received less instruction in coherent sequences. Teachers shifted topics too frequently within the lesson. This teaching method would interrupt the continuity of the lesson and add to the children's difficulty in perceiving the lesson as a coherent whole. For example, Stigler and Stevenson (1991) pointed out that "Shifting the topic, on the other hand, introduces variety, but at the risk of destroying the coherence of the lesson" (p. 17).

While conducting the TIMSS video study, Stigler and Hiebert (1997) found that in contrast to teachers in East Asia, U.S. teachers did not use common language while teaching mathematics. They indicated the following:

> Even within the U.S., we lack shared meanings for the words we use to describe teaching. One teacher will call something "problem solving" while her colleague next door calls the same thing a "routine exercise." The problem of no shared language is compounded in a cross-cultural

> questionnaire study. The responses are nearly impossible to interpret. (Conducting the TIMSS video study, ¶ 2)

Assessment

In *Principles and Standards for School Mathematics* (2000), the National Council of Teachers of Mathematics (NCTM) stated the principle assessment as follows:

> Assessment should be more than merely a test at the end of instruction to see how students perform under special conditions; rather, it should be an integral part of instruction that informs and guides teachers as they make instructional decision. Assessment should not merely be done to students; rather, it should also be done for students, to guide and enhance their learning. (p. 22)

As mathematics reform crossed the U.S., new assessment strategies and practices could no longer be limited to paper-and-pencil tasks, end-of-chapter tests, and multiple-choice formats. The NCTM (2000) indicated that assessment should be a routine part of the ongoing process, an enhancement to students' learning, and informational to assist teachers to make effective instructional decisions. Assessment should reflect the mathematics that all students need to know and be able to do, and it should focus on students' understanding as well as their procedural skills. Feedback from assessment tasks could help students

in setting goals, assuming responsibility for their own learning, and becoming more independent learners.

The NCTM (2000) also provided a variety of assessment techniques for documenting student learning. These assessment techniques included open-ended questions, constructed-response tasks, selected response items, performance tasks, observations, conversations, journals, and portfolios. All of these assessment methods could be appropriated for mathematics teaching in the classroom.

Black and Wiliam (1998) argued that teachers need to know about their pupils' progress and difficulties with learning so that they can adapt their own work to meet pupils' needs—needs that are often unpredictable and that vary from one pupil to another. As all teachers make assessments in every class they taught the authors suggested three important questions for them to seek answers to in raising standards in education and improving students' academic achievement in statewide standardized testing.

- Is there evidence that improving formative assessment raises standards?
- Is there evidence there is room for improvement?
- Is there evidence about how to improve formative assessment? (p. 140)

Reformation of the Mathematics Curriculum in Taiwan

Ou (1999) stated that with the 21st century at the threshold, every country has given a top priority to education in the hope of improving the quality of national standards and enhancing international competitive power through education. Therefore, Taiwan also ran into the pressure of educational reform. The Ministry of Education, the Republic of China (ROC) (December 10, 1999) noted that this new curriculum ensured consistency in a nine-year national education. It not only connected the learning of elementary to junior high schools, but also integrated various learning experiences.

The Ministry of Taiwan Education stated that in this rapidly changing world, mathematics will have significantly enhanced opportunities and options for shaping citizens' futures. The mathematical competence opens doors to productive futures. A lack of mathematical competence keeps doors closed. The Ministry of Taiwan Education emphasized that mathematics has strongly related to daily life and mathematics education would help students to learn and also to enjoy learning. Therefore, The Ministry of Taiwan Education has developed new "1st to 9th grade curriculum alignment" for mathematics learning areas.

The goals for students to achieve for this "1st to 9th grades curriculum alignment" are as follows:

1. Master the concepts and relationships among number, measurement, and shape.

2. Cultivate mathematical connections among daily life needs.
3. Develop the process of mathematics problem solving and problem solving abilities.
4. Cultivate using mathematics to express mathematical ideas precisely, and organize and consolidate mathematics thinking through communication.
5. Cultivate mathematical critique and reasoning abilities.
6. Cultivate aesthetic mathematics abilities. (Ministry of Taiwan Education, Draft, p. 186)

In order to achieve these goals for the "1st to 9th grades curriculum alignment," the Ministry of Taiwan Education has indicated that mathematics learning areas should focus on educating the students in mathematics by relating and correlating areas of study to real life, which could permanently ingrain the mathematical relations to the students' daily lives.

Essential Academic Learning Requirements of Washington State

In 1992, the Washington State legislature passed the Educational Reform Act. The Legislature created and changed the Commission on Student Learning to develop statewide performance standards called the Essential Academic Learning Requirements (EALRs). The EALRs in mathematics contained components for students to build up their confidence and proficiency in mathematics. As a guide to attain these components, the Office of

Superintendent of Public Instruction (OSPI) developed a set of EALRs that needed to be taught in the schools in the state of Washington. These skills are then tested at the fourth, seventh, and tenth grades with the Washington Assessment of Student Learning (WASL).

The standards are as follows:

1. The student understands and applies the concepts and procedures of mathematics.

   To meet this standard, the student will:

   1.1 understand and apply concepts and procedures from number sense

   1.2 understand and apply concepts and procedures from measurement

   1.3 understand and apply concepts and procedures from geometric sense

   1.4 understand and apply concepts and procedures from probability and statistics

   1.5 understand and apply concepts and procedures from algebraic sense

2. The student uses mathematics to define and solve problems.

   To meet this standard, the student will:

   2.1 investigate situations

   2.2 formulate questions and define the problem

2.3 construct solutions

3. The student uses mathematics reasoning.

   To meet this standard, the student will:

   3.1 analyze information

   3.2 predict results and make inferences

   3.3 draw conclusions and verify results

4. The student communicates knowledge and understanding in both everyday and mathematical language.

   To meet this standard, the student will:

   4.1 gather information

   4.2 organize and interpret information

   4.3 represent and share information

5. The student understands how mathematical ideas connect within mathematics, to other subject areas, and to real-life situations.

   To meet this standard, the student will:

   5.1 relate concepts and procedures within mathematics

   5.2 relate mathematical concepts and procedures to other disciplines

   5.3 relate mathematical concepts and procedures to real life situations

   (OSPI, 2001, September)

Each standard acts as a set of objectives for the teacher to guide students to achieve the academic standard.

Summary

The research and literature summarized in Chapter 2 supports the following themes:

1. In today's and tomorrow's complex and global economy, mathematics plays an important role by preparing individuals to absorb new ideas, to perceive patterns and solve unconventional problems, and to adapt to the constant change in our technologically advanced world.
2. The mathematics education system in East Asia is more centralized than in the Western countries. In contrast to the Western countries, the mathematics curriculum in East Asia is more coherent and consistent through out each grade. Designing of a coherent curriculum is necessary for students who need to take standard examinations in the United States. Students will perform well if the curriculum is coherent.
3. The structure of teaching styles in East Asia is teacher-centered and subject-mattered. On the other hand, the structure of teaching styles in Western countries is student-centered. The system of mathematics teaching methods and teaching patterns would directly influence the students' learning outcomes.
4. With the reform of the mathematics curriculum, assessment is used as a tool to help teachers and students keep track of their progress toward higher standards in mathematics.

5. In facing the 21st century, the Ministry of Taiwan Education has developed a new set of mathematics curriculum to meet the needs of today's society. The content of mathematics would focus on the problem-solving process and inferring abilities.
6. Washington Essential Academic Learning Requirements (EALRs) have mandated curriculum decisions in mathematics. This EALRs would help students to meet WASL.

CHAPTER 3

PROCEDURES OF THE PROJECT

The purpose of this project was to compare cross-cultural mathematics teaching in the elementary schools in East Asian and Western countries, particularly focused on Taiwan and the United States. Another purpose was to design and develop a common mathematics curriculum program for elementary schools to use in both environments. To accomplish this purpose, a review and comparison of current research and literature regarding current curriculum and teaching practice of mathematics in Taiwan and the United State was conducted. Additionally, related information from selected sources was obtained and analyzed.

Chapter 3 contains background information describing:

1. Need for the Project
2. Development of Support for the Project
3. Procedures
4. Planned Implementation and Assessment of the Project

Need for the Project

The need for the project was influenced by the following considerations:

1. The writer, Hui-Nuan Huang, a student of operations management/information systems, held a Bachelor of Science degree

in Business Administration from Central Washington University, Ellensburg.

2. Because of her years of studying in Taiwan, Singapore, and the United States and the opportunity to undertake graduate studies at Central Washington University, and the writer was afforded an opportunity to further pursue her interest in comparing East Asian and Western cultures in the teaching of mathematics in the elementary school.
3. While comparing and contrasting the differences of teaching mathematics in East Asian and Western countries, it became clear that the writer had decided to develop a mathematics curriculum for elementary school use.
4. The writer has incorporated the Taiwan mathematics curriculum alignment and Washington State Essential Academic Learning Requirements in her mathematics approach.
5. Undertaking the study coincided with the writer's graduate studies in educational administration at Central Washington University.

Development of Support for the Project

The writer's 10 years of experience of studying in foreign countries, in combination with the opportunity to participate further in the Master of Education program at Central Washington University, and profoundly influenced her belief that teaching methods and curriculum coherency were both very significant

elements that would undoubtedly impact student learning. Her subsequent decision was to compare cross-cultural mathematics teaching and to develop a coherent mathematics curriculum for elementary school use. Experience with elementary-level administrators, teachers, and students have led to her plans to pursue a career as an elementary mathematics teacher. Following her admittance to the graduate studies program at Central Washington University in 2001, the writer undertook in-depth research related to mathematics curriculum and instruction methods for elementary students.

Procedures

To obtain background information essential for comparing cross-cultural mathematics teaching and developing a coherent mathematics curriculum program for elementary schools to use, research information was identified through Educational Resources Information Center (ERIC) computer search and various Internet searches. Additionally, related information from selected standard model mathematics curriculum was obtained and analyzed.

Planned Implementation and Assessment of the Project

Implementation of the model elementary school mathematics curriculum program has been tentatively scheduled for selected schools during the 2002-2003 school year. Following implementation of the model program, the school administrator will collaborate and cooperate with mathematics teachers to plan

and design performance-based assessment procedures needed to enhance program success. Examples of assessments may include classroom observation, student interviews, and evaluation of student performances. Assessment data will be obtained and used to modify the model of mathematics curriculum program at the discretion of the administration and mathematics teachers.

CHAPTER 4

THE PROJECT

The model elementary school mathematics curriculum to develop common mathematics curriculum for students use in East Asian and Western countries, which was the subject of this project, has been presented in seven units in Chapter 4 as follows:

Unit 1: Introduction

Unit 2: Teaching Methodology

Unit 3: Number and Operations

Unit 4: Measurement

Unit 5: Shape and Space

Unit 6: Algebra

Unit 7: Data Analysis and Probability

COMPARISON OF EAST ASIAN AND WESTERN CULTURE IN TEACHING MATHEMATICS: A MODEL OF ELEMENTARY SCHOOL MATHEMATICS CURRICULUM

By

Hui-Nuan Huang

Central Washington University

July, 2002

TABLE OF CONTENTS

Unit 1

INTRODUCTION

This project, Elementary School Mathematics Curriculum, was designing to develop common mathematics curriculum for administrators, teachers, and students use in East Asian and Western countries. Administrators and teachers will know the differences of teaching methods between East Asian and Western cultures. Students will make the connection by applying their mathematics concepts to what they experience in daily life.

In order to prepare today's students to access tomorrow's world, the goals of teaching mathematics and of designing coherent mathematics curriculum are both significant demands of a global economy in an age of information. This project—Comparison of East Asian and Western Culture in Teaching Mathematics: A Model of Elementary School Mathematics Curriculum—is designed to meet the demands of these two goals.

This project will focus on the following topics:

- Teaching Methodology: Comparing cross-culture teaching methods, especially focus on Taiwan and the United States.
- Number and Operations: Introducing students to simple addition, subtraction, multiplication, and division.
- Measurement: Introducing students to the attributes of length, weight, time, volume, area, and distance.
- Shape and Space: Introducing students to two-and three-dimensional shapes.

- Algebra: Introducing students to forming equations by using algebraic symbols, and to analyze, recognize, and extend patterns.
- Data Analysis and Probability: Introducing students to simple data analysis, using measures of central tendency to describe data, and to predict the probability of outcomes.

Unit 2

UNIT 2

TEACHING METHODOLOGY

Contents Page

TEACHING METHODOLOGY

Overview

This unit will provide school administrators and teachers opportunities to learn the difference of teaching methods between Taiwan and the United States. Through this comparison of cross-cultural teaching methods, they will determine which teaching methods would assist students to build up a foundation in leaning mathematics.

Objectives

The school administrators and teachers will be able to

1. Assist students to achieve national mathematics standards and performance in assessments.
2. Develop concepts of teaching mathematics that proceed from the simple to the complex along with assessing students' progress.
3. Identify the needs of students and teachers.
4. Improve the quality of teaching skills.
5. Reform in teaching mathematics and to see if they are implementing teaching reforms in their classrooms.
6. Understand different systems of teaching methods.

Different Teaching Methodologies between Taiwan and U.S.

Different teaching methodologies between Taiwan and the U.S. include:

1. Classroom Organization
2. Curriculum
3. Instructional Materials
4. Sequences of Lesson Plan
5. Teaching Methods

	Taiwan	**United States**
Classroom Organization	Taiwan's population is heavily concentrated in urban areas, and, as a result, class sizes in city schools average around 50 students and those in suburban areas average around 35.	The class-size in the U.S. is small with an average around 25 students.
Curriculum	1. In 1998, the Ministry of Taiwan Education set up a new national coherent mathematics curriculum. A clear national mathematics curriculum outline from grade one to grade nine was provided for each school district to use. 2. The frameworks of the mathematics curriculum are coherent and standard. It is well articulated across the	1. The curriculum in the United States is decentralized. Every state is responsible for devising its own curriculum. 2. The frameworks of the mathematics curriculum are not coherent and content standards. 3. A large number of topics are covered in each grade. As such, either certain topics

	grades. 3. A fundamental content standard emphasizes on instruction. Students' learning is based on a deep understanding of fundamental content. 4. This new mathematics curriculum alignment focuses on solving process and inferring abilities.	would not be taught or certain topics would be repeated every grade. 4. The mathematics curriculum focuses on solving problems and connecting mathematics idea to real-life situations.
Instructional Materials	1. All instructional materials contents are approved by the Ministry of Taiwan Education. 2. Textbook companies publish standard teachers' manuals that provide detailed teaching plans for each unit in every grade. Textbook companies also publish standard workbooks for students to practice. The content of workbooks is developed based on simple computational skills or symbolic representations and routine problem-solving skills but less use on creative thinking. 3. The textbooks are slim, and separate volumes	1. The contents of instructional materials are not consistent or standard due to each state having its own different standard of mathematics curriculum. 2. Textbook companies publish teachers' manuals that deal with broader issues such as creating a learning environment, using manipulation, and integrating technology. Textbook companies also publish workbooks for students to practice. The content of workbooks is developed based on concrete visual or pictorial representations but less use on abstract.

	are used for each semester.	3. American textbooks are thick and each volume covers a whole year's work.
Sequences of Lesson Plan	1. The lesson would start with the teacher reviewing a previous lesson and assigning a problem that was not finished. 2. Then, the teacher would introduce the new lesson topic and start developing it in some length through explanation. The teacher would also provide alternative solving methods that would connect to previous lessons. 3. Toward the end of the class, the teachers would ask a few students to perform their work on the board and quickly summarize the lesson. 4. The teacher would assign homework at the end of the class period.	1. The lesson would begin with a "warm-up" activity by asking students short-answer questions. 2. The teacher would check homework by calling on students for answers. 3. The teacher would distribute worksheets with similar problems and students would work as a group. While students are working, the teacher would monitor the students' work. 4. The teacher would review another worksheet and demonstrate a method for solving the most challenging problem. 5. The teacher would conduct a quick oral review of problems and have students complete an unfinished worksheet as homework.
Teaching Methods	1. The national teaching method has shifted	1. The teaching methods are cooperative

	from subject-oriented to area-oriented. 2. The teaching styles still remain as teacher-centered and teachers use the whole class instruction method. 3. Standard terms of mathematics are used in teaching.	learning and hands-on activities. 2. The teaching styles are student-centered and small class size. 3. No standard terms of mathematics are used in teaching

Similar Teaching Methodologies between Taiwan and U.S.

Similar Teaching Methodologies between Taiwan and U.S. include:

1. Effective teaching involving observing students, listening carefully to their ideas and explanations, and using information to make instructional decisions.
2. Mathematics classrooms encourage an atmosphere of student problem solving.
3. Teaching students to apply mathematics concepts to everyday life situations.
4. Teaching students to analyze and evaluate mathematical thinking.
5. Teaching students to reach academic achievement.
6. Teaching students to see mathematical connections in the rich interplay among mathematical topics and in contexts that relate mathematics to other subjects.

7. Teaching students to share ideas and clarify understanding through communication.
8. Using assessment tools to enhance students' learning progress.
9. Using assessment tools to enhance teachers' instruction.

Unit 3

UNIT 3

NUMBER AND OPERATIONS

Contents Page

NUMBER AND OPERATIONS

Overview

The Number and Operations unit introduces the students to simple addition, subtraction, multiplication, and division. Each lesson is designed to target different learning areas from grades 1 to 3 and from grades 4 to 6:

- ❖ Lesson 1: Adding and Subtracting by Counting On
- ❖ Lesson 2: Adding and Subtracting from the Front End
- ❖ Lesson 3: Multiplication Tables
- ❖ Lesson 4: Rounding in Addition, Subtraction, Multiplication, and Division
- ❖ Lesson 5: Converting Fractions to Decimals, Converting Decimals to Fractions
- ❖ Lesson 6: Using Rules for Order of Operations

Objectives of Lesson Plans

Grade 1 to 3 students will be able to

- Develop and use strategies for whole number computation with a focus on addition and subtraction in first grade and second grade.
- Develop and use strategies for whole number computation with a focus on multiplication in third grade.
- Develop understanding of the relative position and magnitude of whole numbers and of ordinal and cardinal numbers and their connections.

- Discover what mathematics reveals about daily life situations.
- Understand and communicate about daily life in order to solve problems.
- Understand the place-value structure of the base-ten number system up to 1,000 and be able to represent and compare whole numbers and decimals.
- Understand when to add, subtract, multiply, or divide whole numbers.

Grade 4 to 6 students will be able to

- Compare and order fractions, decimals, and percents efficiently and find their approximate locations on a number line.
- Develop fluency in adding, subtracting, multiplying, and dividing whole numbers.
- Discover what mathematics reveals about daily life situations.
- Round large numbers to the nearest hundred or thousand for better understanding and computing of numbers.
- Understand and communicate about daily life in order to solve problems.
- Understand the place-value structure of the base-ten number system up to 100,000.
- Understand fractions as parts of whole units, as divisions of whole numbers, and as locations on number lines.

Learning Activities

Learning activities for grades one to six will be designed coherently and consistently with the unit's student learning objectives. The activities include:

- Completing the written assignments.
- Completing mathematics assignments.
- Developing a unit portfolio.
- Keeping a daily journal.
- Participating in lesson introduction warm-ups.
- Participating in class reading.
- Taking daily quizzes.

Teaching Strategies

Teaching strategies for grades one to six include:

- Cooperative learning groups.
- Individual class work.
- Problem solving.
- Using manipulatives (calculators, computers, games, tools...).
- Whole class instruction and discussion.

Assessment

Assessment for grades one to six will be consistent with student learning objectives. Assessment includes:

- Classroom assignments.
- Communication proficiencies (reading, writing, listening, and speaking).
- Daily quizzes.
- Student portfolio.
- Unit test.

Instructional Materials

Instructional materials for grades one to six include:

- Book, *Mental Mathematics for the Numeracy Hour.*
- Calculator, rulers, papers, and an overhead projector.
- Internet resources and computer software.
- Textbook, *Elementary and Middle School Mathematics: Teaching Development, 3rd Edition.*

Grades 1-3

Unit 3: Number and Operations

Lesson 1

Introduction Activity for Lesson:

Adding and Subtracting by Counting On

Learning Target: **Using simple addition and subtraction to apply to on daily situations, such as counting money, telling time...**

Instructional Materials: **1. Blocks**

2. Pencils

3. Worksheets

Activities:

1. Tell students that there are six blocks on the table. After adding 8 blocks more, ask, "How many blocks are on the table?" Have students guess until the right number is guessed. When the correct number is guessed, have the students start with that number and "count on." Repeat using different numbers.
2. Have students work in groups for more complicated problems.
3. Give each student a worksheet to work on the problems.

Worksheet

Name: _____

Fill out the missing parts

2 + _____ = 9

6 – 2 = _____

5 + 14 = _____

9 - _____ = 15

_____ + 7= 13

_____ - 11 = 20

9 + 6 =_____

12 – 8 = _____

15 + _____ = 15

8 - _____ = 0

_____ + 4 = 10

_____ - 18 = 2

Grades 1-3

Unit 3: Number and Operations

Lesson 2

Introduction Activity for Lesson:

1. **Adding from the Front End**
2. **Subtracting from the Front End**

Learning Target: **Knowing that computation is something flexible. This realization is an enormous step toward confidence and competence in mathematics.**

Instructional Materials:

1. **Base ten blocks and individual blocks**
2. **Base ten graph papers**
3. **Pencils**
4. **Worksheets**

Instructions:

1. Show the problem 22 + 16 by using base ten blocks.
2. Point out that to add 22 and 16, we can join the tens (3 tens) and ones (8 ones).
3. By looking at the model, students will figure out the answer.
4. Give each student a worksheet to work on the problems and a helping tool—a base ten graph is provided to each student to use.

Worksheet

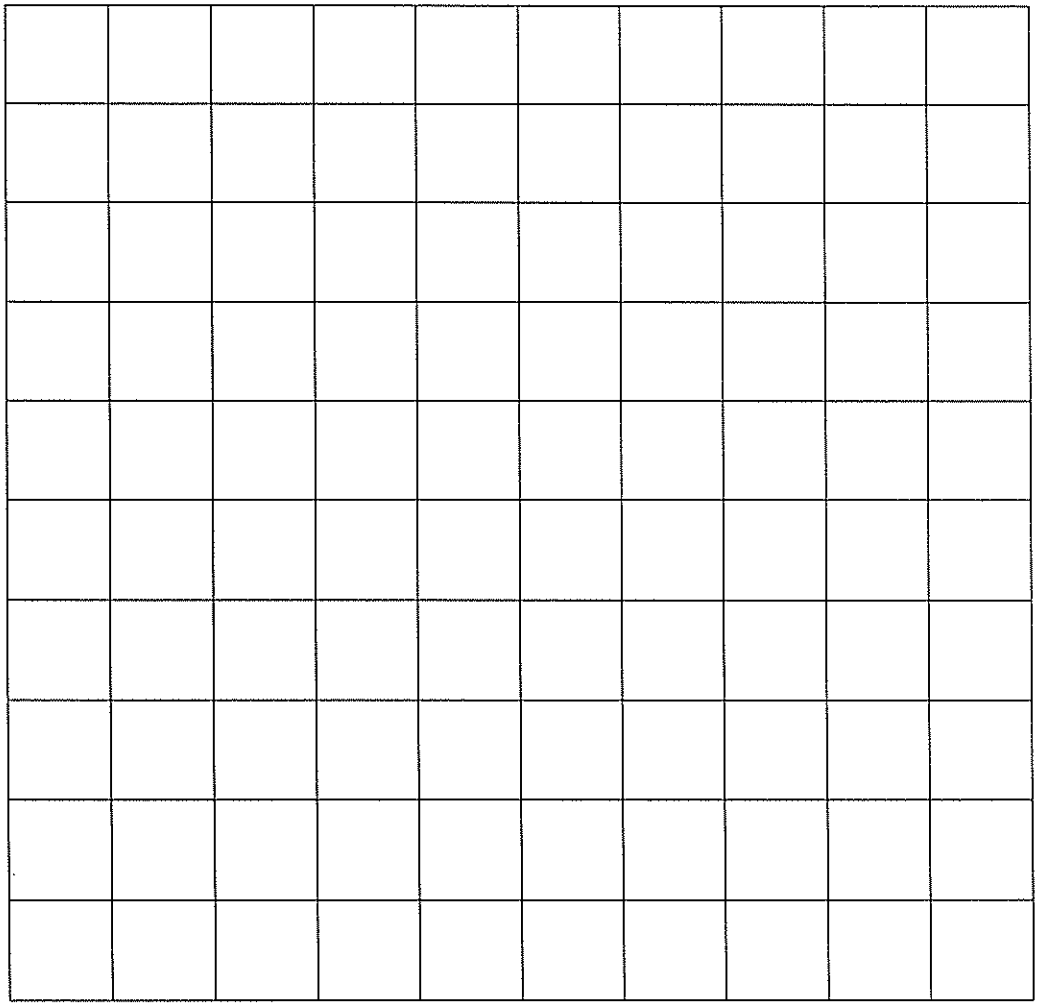
Name _____

Example:

25 + 14 =	TENS	ONES	SUM
	3	9	39

1. 3 tens + 4 =
2. 7 tens + 14 =
3. 9 tens + 2 =
4. 12 + 4 tens =
5. 20 + 6 tens =
6. 2 tens + 5 tens =
7. 1 ten – 3 =
8. 4 tens – 14 =
9. 8 tens – 3 tens =
10. 6 tens – 3 tens =
11. 34 – 1 ten =
12. 55 – 4 tens =

Base Ten Graph



Grades 1-3

Unit 3: Number and Operations

Lesson 3

Introduction Activity for Lesson:

Multiplication Tables

Learning Target: **Helping students systematically learn their multiplication tables. Students will discover that one as a factor gives a product that is the same as the other factor.**

Instructional Materials: **1. Multiplication Tables**

2. Buttons

3. Pencils and worksheets

Activities:

1. Have students investigate the results of using one as a factor for any number by using buttons.
2. Students will examine the products of 1 x 1, 1 x 2, 1 x 3,..., 1 x 9, 1 x 10 and then examine the products of 2 x 1, 2 x 2, 2 x 3,..., 2 x 9, 2 x 10.
3. Lead students in a discussion of how these arrays are different and how they are alike by the looking at the buttons.
4. Distribute multiplication tables to each student and have each student work on the worksheets.
5. Give students drills on the multiplication tables each day.

Worksheet 1

Name _____

- 1 x 10 =
- 10 x 1 =
- 2 x 8 =
- 8 x 2 =
- 3 x 5 =
- 5 x 3 =
- 4 x 9 =
- 9 x 4 =
- 5 x 6 =
- 6 x 5 =
- 6 x 2 =
- 2 x 6 =
- 7 x 4 =
- 4 x 7 =
- 8 x 5 =
- 5 x 8 =
- 9 x 10 =
- 10 x 9 =
- 10 x 2 =
- 2 x 10 =

Worksheet 2

Name _____

1. 25 x 7

2. 12 x 10

3. 6 x 14

4. 22 x 5

5. 6 x 3

6. 14 x 5

7. 22 x 11

8. 30 x 0

Multiplication Tables

X	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	4	6	8	10	12	14	16	18	20
3	3	6	9	12	15	18	21	24	27	30
4	4	8	12	16	20	24	28	32	36	40
5	5	10	15	20	25	30	35	40	45	50
6	6	12	18	24	30	36	42	48	54	60
7	7	14	21	28	35	42	49	56	63	70
8	8	16	24	32	40	48	56	64	72	80
9	9	18	27	36	45	54	63	72	81	90
10	10	20	30	40	50	60	70	80	90	100

Grades 4-6

Unit 3: Number and Operations

Lesson 4

Introduction Activity for Lesson:

1. **Rounding in Addition and Subtraction**
2. **Rounding in Multiplication and Division**

Learning Target: **Determine appropriateness of estimation; use estimation to predict computation results; determine reasonableness of answers.**

1. Estimate the differences by rounding the numbers to the nearest **hundred**. Show your work.

$$1856.85 - 723 + 3845 =$$

2. Estimate the differences by rounding final answer to the nearest **thousand**.

   Show your work.

   $950 \times 45 \div 15 =$

Grades 4-6

Unit 3: Number and Operations

Lesson 5

Introduction Activity for Lesson:

1. Converting Fractions to Decimals
2. Converting Decimals to Fractions

Learning Target: **Using multiplication and division to convert fractions to decimals and to convert decimals to fractions.**

1. Write each fraction as a decimal in the nearest **hundredth**. Show your work.

- $\frac{9850}{1500}$
- $\frac{750}{25}$

2. Write each decimal as a fraction in the **simplest form**. Show your work.

- 0.8
- 0.0804
- 2.5
- 5.07

Unit 3: Number and Operations

Lesson 6

Introduction Activity for Lesson:

Using Rules for Order of Operations

Learning Target: **Add, subtract, multiply, and divide non-negative whole numbers, fractions, and decimals using rules for the order of operations.**

What is the correct value of the expression below?

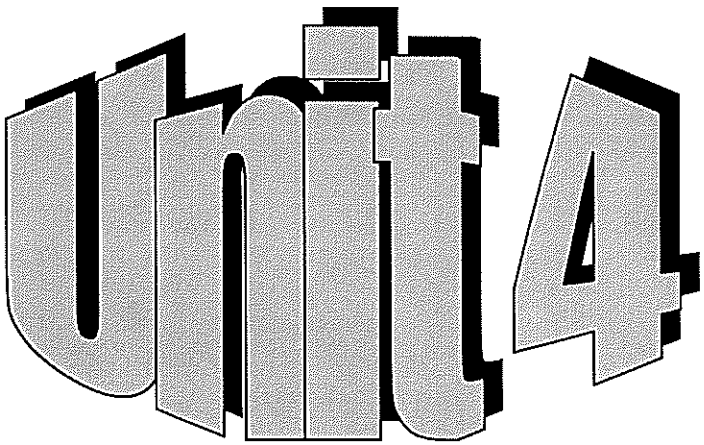
$$12 + 2 \times 35 \div 0.1 - 8$$

A. 700

B. 812

C. 704

D. 986


Unit 4

UNIT 4

MEASUREMENT

Contents

MEASUREMENT

Overview

The Measurement unit introduces students to developing a basic understanding of measurement. Students learn about the attributes of length, weight, time, volume, area, and distance. Each lesson is designed to target different learning areas for grades 1 to 3 and for grades 4 to 6:

- ❖ Lesson 1: Measuring Length with Nonstandard and Standard Measuring Tools
- ❖ Lesson 2: Time and Clock Reading
- ❖ Lesson 3: Comparing Weight
- ❖ Lesson 4: Estimating Time to Finish Painting
- ❖ Lesson 5: Converting Units
- ❖ Lesson 6: Measuring the Volumes of Different Containers

Objectives of Lesson Plans

Grade 1 to 3 students will be able to

- Compare and order objects according to the attributes of length, distance, volume, weight, area, and time.
- Discover what mathematics reveals about daily life situations.
- Know how to read time in hours, minutes, and seconds.
- Select and use appropriate tools for measure.

- Understand and communicate about daily life in order to solve problems such as calculating time and date using a calendar.
- Understand how to measure using nonstandard and standard units.
- Use measurement to quantify information about objects.

Grade 4 to 6 students will be able to

- Carry out unit conversions.
- Discover what mathematics reveals about daily life situations.
- Make reasonable predictions of results.
- Understand and communicate about daily life in order to solve problems.
- Understand the attributes of length, distance, area, weight, volumes, and size of angle and select the appropriate type of unit for measuring each attribute.
- Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems.
- Use measurement to quantify information about objects.

Learning Activities

Learning activities for grades one to six will be designed coherently and consistently with the unit's student learning objectives. The activities include:

- Completing mathematics assignments.
- Developing a unit portfolio.

- Keeping a daily journal.
- Participating in lesson introduction warm-ups.
- Participating in class reading.
- Taking daily quizzes.

Teaching Strategies

Teaching strategies for grades one to six include:

- Cooperative learning groups.
- Individual class work.
- Problem solving.
- Using manipulatives (calculators, computers, games, tools...).
- Whole class instruction and discussion.

Assessment

Assessment for grades one to six will be consistent with student learning objectives. Assessment includes:

- Classroom assignments.
- Communication proficiencies (reading, writing, listening, and speaking).
- Daily quizzes.
- Student portfolio.
- Unit test.

Instructional Materials

Instructional materials for grades one to six include:

- Book, *Math Link: Teaching the NCTM 2000 Standards through Children's Literature.*
- Calculator, rulers, papers, and an overhead projector.
- Internet resources and computer software.
- Textbook, *Teaching and Learning elementary and Middle School Mathematics, 3rd Edition.*

Grades 1-3

Unit 4: Measurement

Lesson 1

Introduction Activity for Lesson:

Measuring Length with Nonstandard and Standard Measuring Tools

Learning Target: **Students will determine how to select and use appropriate tools to measure with. Students will be able to measure length with nonstandard and standard units. Students will learn how to read the length units.**

Instructional Materials:

1. **Length Unit Tables**
2. **Pencils**
3. **Nonstandard measuring tools such as pencils, rods, straws, and tiles**
4. **Standard measuring tools such as centimeter rulers, meter rulers, or inch rulers**

Activities:

1. Students will measure objects such as tables, chairs, books, or backpacks with nonstandard measuring tools.
2. Discuss how an object can be measured with various nonstandard measuring tools, with various results from each measuring tool.
3. Have students measure the objects again, this time using standard measuring tools.

4. Discuss with students that even though the table and book have the same size, their length in centimeters will be a larger number than the length in meters. Help students see that more centimeters are needed to describe the length because the centimeters are smaller units than meters are.
5. Teach students to learn the basic concepts of the length units.

Length Unit Tables

Attribute	*Customary*	*Abbreviation*
Length	Inch	in.
	Foot	ft
	Yard	yd
	Mile	mi

Attribute	*Metric*	*Abbreviation*
Length	Millimeter	mm
	Centimeter	cm
	Meter	m
	Kilometer	km

Grades 1-3

Unit 4: Measurement

Lesson 2

Introduction Activity for Lesson:

Time and Clock Reading

Learning Target: **Students will learn the duration of an event from its beginning to its end. Students will learn the units of time. Student will learn to read clocks.**

Instructional Materials: **1. Clock**

2. Pencils

3. Worksheets

4. Clock Cards

Activities:

1. Show students the parts of clock.
2. Review of the clock parts: Big hand refers to hour, small hand refers to minutes, and how each number on the clock represents a multiple of five.
3. First, show the time in hours, such as 8 o'clock, 1 o'clock, and 10 o'clock.
4. Introduce the half-hour, then the quarter-hour, five minutes, and one minute.
5. Have students look at the clock and tell the time. Keep repeating the activities.
6. Have students work in groups to complete the worksheets.

Worksheet 1

Name _____

1. Look at the clock. What time is it?

_____:_____ _____:_____

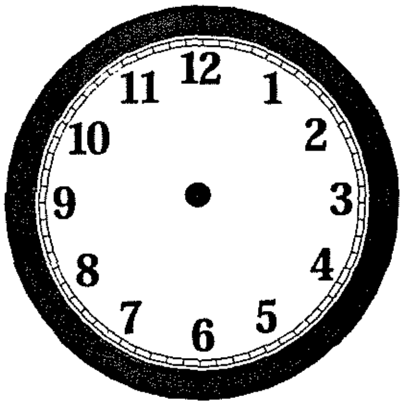
_____:_____

2. Draw the clock on the space below for the following times:

a. 7:25

b. 12:45

Clock Cards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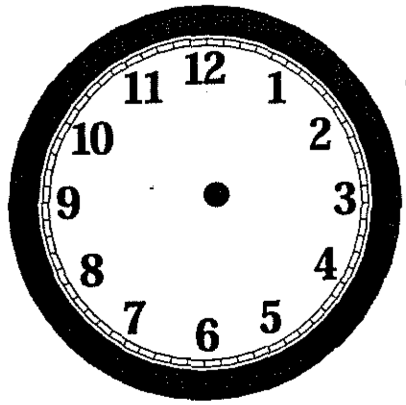
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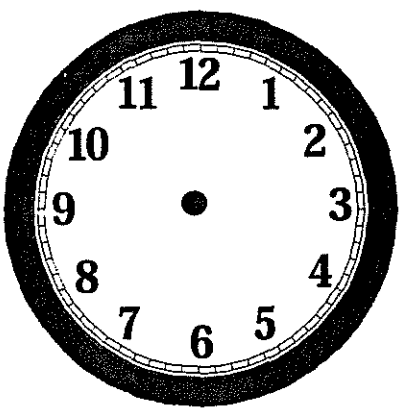
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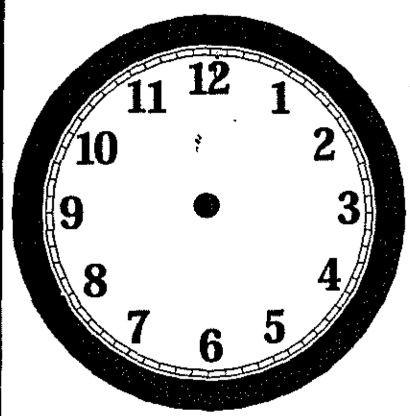
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Grades 1-3

Unit 4: Measurement

Lesson 3

Introduction Activity for Lesson:

Comparing Weight

Learning Target: **Students will estimate which object is heavier. Students will learn to read the correct scale of weight. Students will learn the most common use weight units.**

Instructional Materials:

1. **The objects such as books, building blocks, apples…**
2. **Balance Scales**
3. **Electronic Scale**
4. **Pencils**
5. **Weight Unit Tables**

Activities:

1. Have each student compare the weights of two objects while holding one in each hand.
2. Ask student questions such as "Which object is heavier? What is the estimated weight of the object? How do you know this object is heavier?"
3. Then, have the student place the objects in the two pans of a balance, the pan that goes down can be understood to hold the heavier object.

4. Show students how to read electronic scales. Then, compare with their estimated weights.
5. Teach students to lean the basic concepts of the weight units.

Weight Unit Tables

Attribute	*Customary*	*Abbreviation*
Weight	Ounce	oz
	Pound	lb

Attribute	*Metric*	*Abbreviation*
Weight	Gram	g
	Kilogram	kg

Grades 4-6

Unit 4: Measurement

Lesson 4

Introduction Activity for Lesson:

Estimating Time to Finish Painting

Learning Target: **Use estimation to predict or determine the reasonableness of measurements of time or to obtain reasonable approximations.**

Instructional Materials: **1. Pencils**

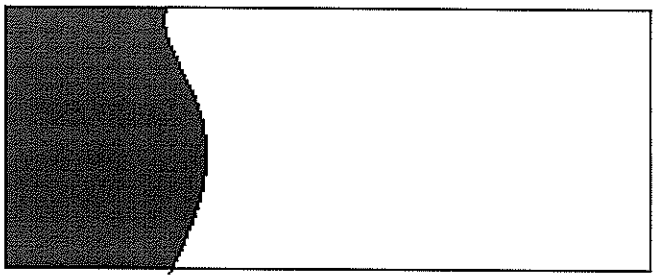
2. Rulers

3. Worksheets

Activities:

1. Students may use ruler to help them to solve the problem.
2. Students can work on this problem in groups and share their answer.
3. Lead students in a discussion of how to get the answer.

At 8 a.m. Kent and John started painting the house. By 9 a.m. they had painted this much of the walls:



If they continue at this rate, at what time they will finish painting the house? If Kent paints the house all by himself, what time will he finish? Show your work.

Grades 4-6

Unit 4: Measurement

Lesson 5

Introduction Activity for Lesson:

Converting Units

Learning Target: **Learning to use unit tables to convert units. Students will learn how to convert from one unit to another unit. Multiplication, division, decimal, and fraction will be reviewed in this lesson.**

Instructional Materials: **1. Converting Unit Tables**

2. Pencils

3. Worksheets

Activities:

1. Converting time units.
2. Converting length units
3. Have students think about what units would be better to use. For example, measure a box or a pool.

Worksheet: Converting Time Units.

Name: _____

Fill out the missing part.

- 1 hour 27 minutes = _____ minutes.
- 188 seconds = _____ minutes.
- 1.20 hours = _____ hour(s) _____ minutes.
- 5100 seconds = _____ hour(s)
- 38 hours = ____ day _____ hour(s) _____minutes.

Show your work in the box.

Worksheet: Converting Length Units

Name: _____

Fill out the missing part.

- 12 mm = _____ cm.
- 58 cm = _____ m.
- 2.34 m = _____ cm.
- 5.98 m = _____ km.
- $\frac{1}{12}$ km = _____m.

Show your work in the box.

Unit Tables

Time Units	***Length Units***
• 1 day = 24 hours	• 1 km = 1000 m
• 1 day = 1440 minutes	• 1 km = 100000 cm
• 1 day = 86400 seconds	• 1 km = 1000000 mm
• 1 hour = 60 minutes	• 1 m = 100 cm
• 1 hour = 360 seconds	• 1 m = 1000 mm
• 1 minute = 60 seconds	• 1 cm = 10 mm

Grades 4-6

Unit 4: Measurement

Lesson 6

Introduction Activity for Lesson:

Measuring the Volumes of Different Containers

Learning Target: **Use arbitrary units to determine the volumes of different containers. Select the measuring tool which will take the least time to fill up the largest container. Students will learn proportions by comparing different containers.**

Instructional Materials:

1. **Eye Droppers**
2. **Tablespoons**
3. **Different Size Containers: small jars, middle jars, and large jars**
4. **Worksheets**
5. **Pencils**

Activities:

1. Have students find a method that will take less time and effort to fill up the largest containers.
2. Ask students to guess how many eye drops of water it will take to fill a table spoon.

3. Next, ask the students to assess the number of tablespoons of water it takes to fill the small jar. Then, find out how many small jars it takes to fill the middle jar and how many middle jars to fill the largest jar.
4. Finally, calculate the volume of the largest jar. State the answer in terms of drops of water.

Worksheet

Name: _____

Calculate the volume of the largest jar which can be stated in terms of drops of water. Show your work in the box.

Unit 5

UNIT 5

SHAPE AND SPACE

Contents Page

SHAPE AND SPACE

Overview

The Shape and Space unit introduces students to understand attributes of measurement and parts of two-and three-dimensional shapes. Each lesson is designed to target different learning areas for grades 1 to 3 and for grades 4 to 6:

- Lesson 1: Developing Simple symmetrical Patterns
- Lesson 2: Differentiate between Two-and Three-Dimensional Shapes
- Lesson 3: Three-Dimensional Shapes
- Lesson 4: Polygon
- Lesson 5: Angles
- Lesson 6: Area, Perimeter, and Volume

Objectives of Lesson Plans

Grade 1 to 3 students will be able to

- Create mental images of shapes and spaces from different perspectives.
- Describe attributes and parts of two- and three-dimensional shapes.
- Develop simple symmetrical patterns with objects.
- Develop vocabulary to describe the attributes of volume and area.
- Discover what mathematics reveals about daily life situations.
- Recognize, name, draw, and sort two- and three-dimensional shapes.

- Relate ideas in shape and space to ideas in number and measurement.
- Understand and communicate about daily life in order to solve problems.

Grade 4 to 6 students will be able to

- Classify two- and three-dimensional shapes according to their properties and develop definitions of classes of shapes such as squares, triangles, pyramids, cylinders, or cones.
- Discover what mathematics reveals about daily life situations.
- Explain mathematical ideas to diverse audiences using visual aids.
- Explore congruence and similarity.
- Find the distance between points along horizontal and vertical lines of a coordinate system.
- Make and use coordinate systems to specify locations and to describe path.
- Recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or in everyday life.
- Understand relationships among the angles, side lengths, perimeters, areas, and volumes of the objects.

Learning Activities

Learning activities for grades one to six will be designed coherently and consistently with the unit's student learning objectives. The activities include:

- Completing the written assignments.
- Completing mathematics assignments.
- Developing a unit portfolio.
- Keeping a daily journal.
- Participate in lesson introduction warm-ups.
- Participating in class reading.
- Taking daily quizzes.

Teaching Strategies

Teaching strategies for grades one to six include:

- Cooperative learning groups.
- Individual class work.
- Problem solving.
- Using manipulatives (calculators, computers, games, tools...).
- Whole class instruction and discussion.

Assessment

Assessment for grades one to six will be consistent with student learning objectives. Assessment includes:

- Classroom assignments.
- Communication proficiencies (reading, writing, listening, and speaking).
- Daily quizzes.
- Student portfolio.
- Unit test.

Instructional Materials

Instructional materials for grades one to six include:

- Book, *Math Link: Teaching the NCTM 2000 Standards through Children's Literature.*
- Book, *Principles and Standards for School Mathematics.*
- Calculator, rulers, papers, and an overhead projector.
- Internet resources and computer software.
- Textbook, *Elementary and Middle School Mathematics: Teaching Development, 3rd Edition.*

Grades 1-3

Unit 5: Shape and Space

Lesson 1

Introduction Activity for Lesson:

Developing Simple Symmetrical Patterns

Learning Target: **Student will recognize symmetrical diagrams. Student will create symmetrical patterns on dot grid papers.**

Instructional Materials:

1. **Dot Grid Papers**
2. **Mirrors**
3. **Objects: Pattern Blocks**
4. **Pencils**

Activities:

1. Teach the term, "symmetrical."
2. Provide mirrors with which students may explore and develop symmetrical patterns.
3. Have students design a diagram by using pattern blocks. Then, have them place a mirror along one edge of the diagram, note the reflection, and copy the image. Ask, "What pattern do you see in your design?"
4. This time, have students place a mirror along one edge of the image they copy. Ask what they see this time.
5. Have students make a new diagram without using the mirror.

Grades 1-3

Unit 5: Shape and Space

Lesson 2

Introduction Activity for Lesson:

Differentiate between Two-and Three-Dimensional Shapes

Learning Target: **Recognize and identify the differences of two-dimensional shapes and three-dimensional shapes.**

Learn the name of the two-dimensional shapes.

Instructional Materials: **1. Pencils**

2. Two-Dimensional Figures

3. Three-Dimensional Objects

4. Worksheets

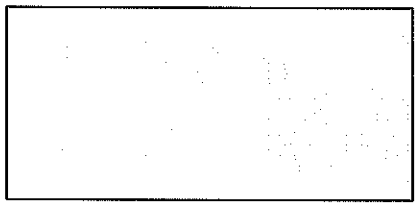
Activities:

1. Teach the definitions of two-and three-dimensional shapes.
2. Show some examples of two-and three-dimensional shapes.
3. Have students point out two-dimensional figures and three-dimensional objects in the classroom.
4. Have students look at a graph and discuss how many different shapes they can find.
5. Have students work on the worksheets.

Worksheet 1

Name: _____

Label Two-Dimensional Shapes



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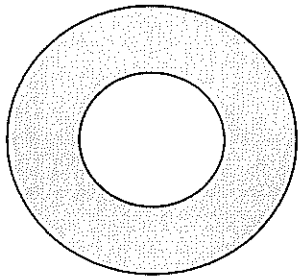

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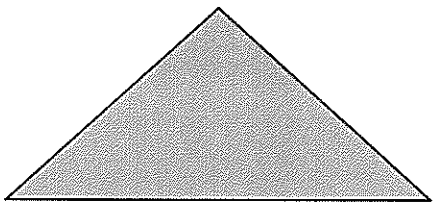

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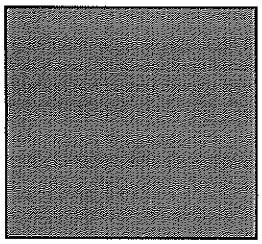

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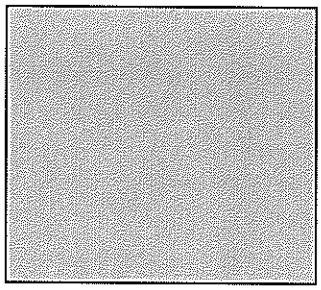
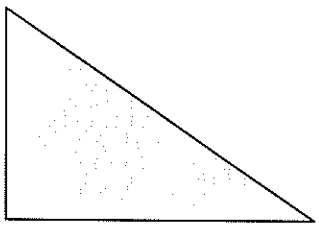
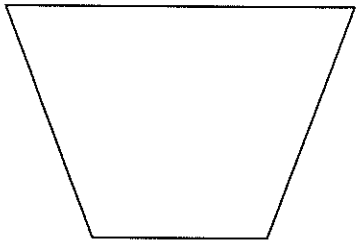
Worksheet 2

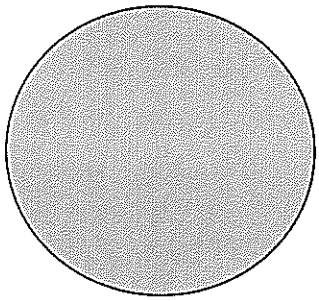
Name: _____

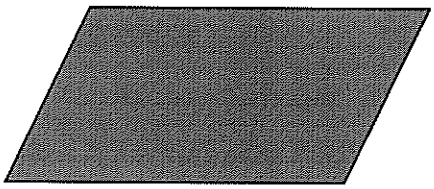
Use these two-dimensional shapes to construct a picture. Name the shapes on the picture you draw.

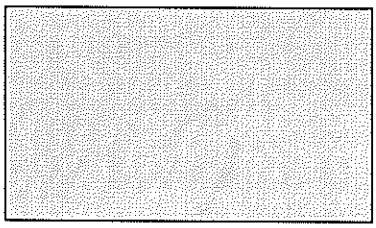












Grades 4-6

Unit 5: Shape and Space

Lesson 3

Introduction Activity for Lesson:

Three-Dimensional Shapes

Learning Target: **Recognize, identify, and name two- and three-dimensional shapes,**

Instructional Materials: **1. Pencils**

2. Two-Dimensional Figures

3. Three-Dimensional Objects

4. Worksheets

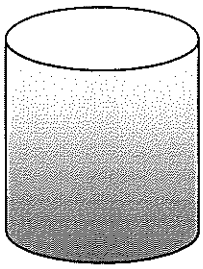
Activities:

1. Teach the definitions of two-and three-dimensional shapes.
2. Have students point out what are the two-dimensional figures and three-dimensional objects in the classroom.
3. Compare the differences of two-and three-dimensional shapes.
4. Have students look at a graph and discuss how many different two-and three-dimensional shapes they can find.
5. Have students work on the worksheets.

Worksheet 1

Name: _____

Label Three-Dimensional Shapes



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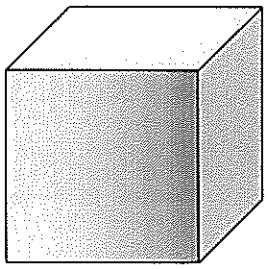

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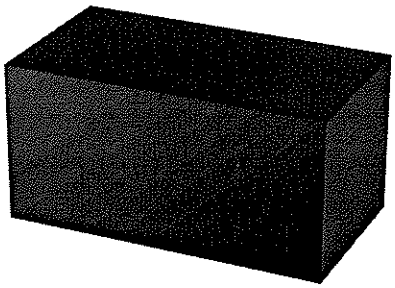

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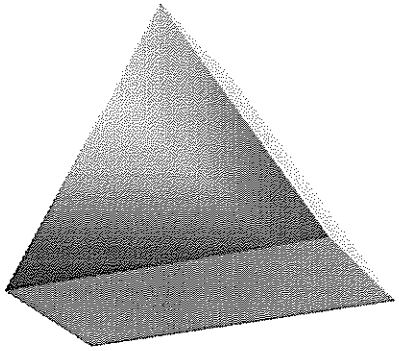

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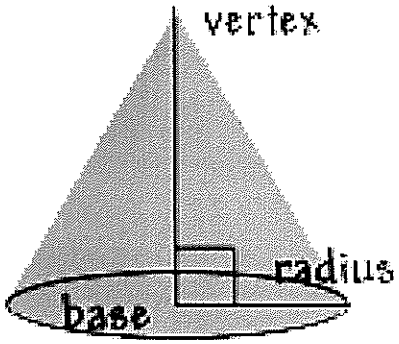
Worksheet

Name: _____



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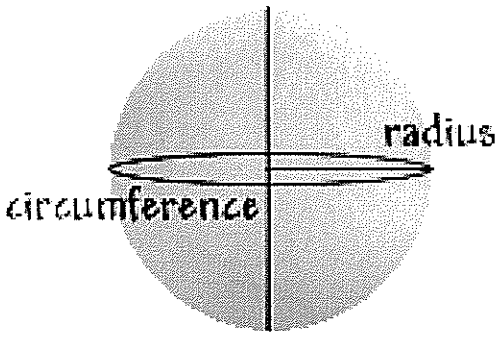

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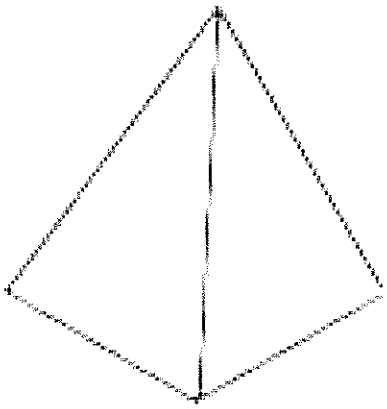

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Grades 4-6

Unit 5: Shape and Space

Lesson 4

Introduction Activity for Lesson:

Polygon

Learning Target: **Student will identify and use geometric properties and relationships to draw and describe shapes, figures, and scale drawings.**

Instructional Materials:

1. **Handouts**
2. **Pencils**
3. **Two-dimensional shapes**
4. **Worksheets**

Activities:

1. Teach students the basic concepts of geometric properties and relationships of the shapes.
2. Give an example: the geometric properties and relationship of a quadrilateral polygon.
3. Have students work on the rest of the examples and share their answers with their classmates.

Worksheet

Name: _____

1. A ***regular polygon*** is a figure in which all of the sides are equal in length and all of the angles are equal in measure. According to this definition, draw two different ***regular polygons*** in the box below.

1.
2.

Handout: ***Rules of Quadrilaterals***

Name: _____

	Do the diagonals always bisect each other	Are the diagonals always equal in length?	Are the diagonals always perpendicular?
Parallelograms	Yes	No	No
Rectangles	Yes	Yes	No
Rhombuses	Yes	No	Yes
Squares	Yes	Yes	Yes

Grades 4-6

Unit 5: Shape and Space

Lesson 5

Introduction Activity for Lesson:

Angles

Learning Target: **Student will learn the concepts of right, acute, and obtuse angles.**

Instructional Materials: **1. Pattern Blocks**

2. Papers

3. Pens

Instructional Procedures:

1. Teach students the definition of right, acute, and obtuse angles.
2. Hand out the pattern blocks to the students.
3. Give time for students to examine the pattern blocks.
4. Have students look at the pattern blocks, and find ones that contain acute angles, and hold them up in the air. Keep repeating these activities.
5. Have students summarize their thoughts in their daily journal.

Grades 4-6

Unit 5: Shape and Space

Lesson 6

Introduction Activity for Lesson:

Area, Perimeter, and Volume

Learning Target: **Students will apply the concepts of area, perimeter, and volume to real world experiences. Students will select the appropriate tools to measure the length, the width, and the height of the objects, and learn measuring units. Student will learn the relationships between area and volume.**

Instructional Materials:

1. **Boxes**
2. **Handouts**
3. **Pencils**
4. **Rulers**
5. **Worksheets**

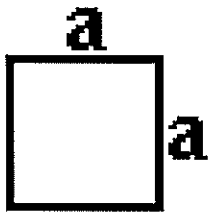
Activities:

1. Teach the concepts of area, perimeter, and volume.
2. Show the relationships between area and volume.
3. Teach the formula of areas, perimeter, and volume.
4. Hand out boxes to students.

5. Have students measure the length, the width, and the height of the box, and write down the numbers.
6. Have students use formulas to calculate the area, perimeter, and volume of the box.

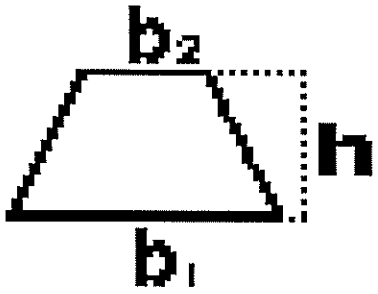
Handout: ***Area Formulas***

Name: _____



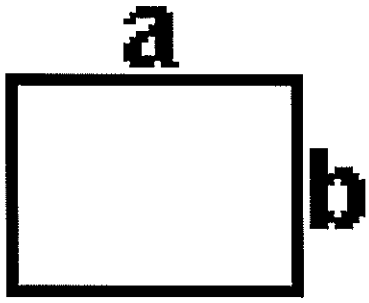
Square

A = a x a



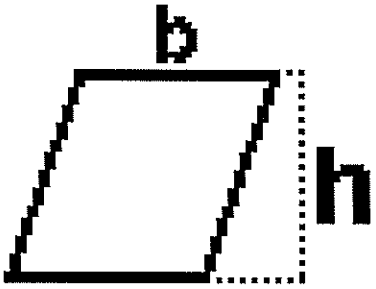
Trapezoid

A = h/2 (b1+b2)



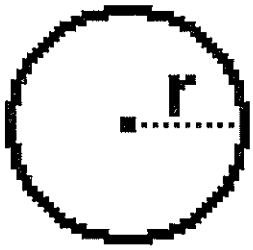
Rectangle

A = a x b



Parallelogram

A = b x h

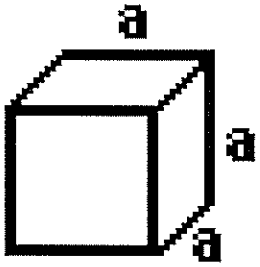


Circle (π = pi = 3.141592…)

$A = \pi r^2$

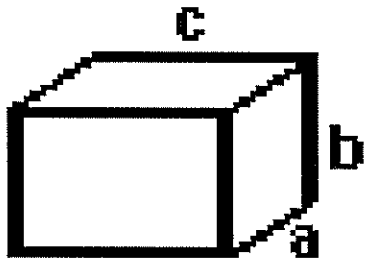
Handout: ***Area Formulas***

Name: _____



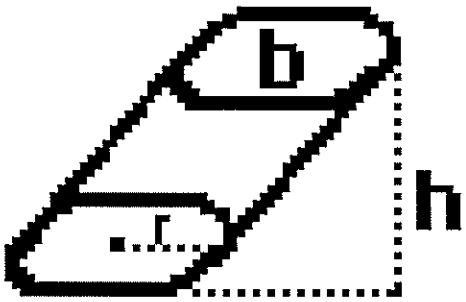
Cube

$V = a \times a \times a$



Rectangular Prism

$V = a \times b \times c$

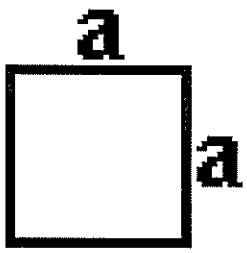


Cylinder (π = pi = 3.141592…)

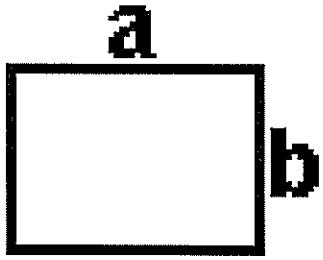
$V = \pi r^2 h$

Handout: ***Perimeter Formulas***

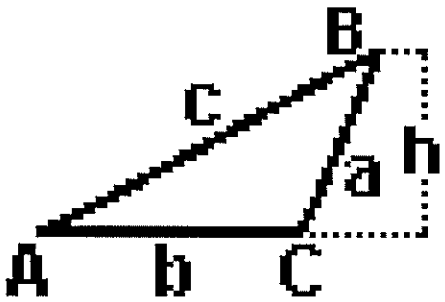
Name: _____



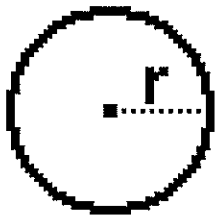
Square = 4a



Rectangle = 2a + 2b



Triangle = a + b + c



Circle = 2∏r

(∏ = pi = 3.141592…)

Unit 6

UNIT 6

ALGEBRA

Contents Page

ALGEBRA

Overview

The Algebra unit introduces students to forming equations by using algebraic symbols. The Students will analyze, recognize, and extend patterns in shapes or numbers. Each lesson is designed to target different learning areas from grades 1 to 3 and from grades 4 to 6:

- ❖ Lesson 1: Discovering and Repeating Patterns
- ❖ Lesson 2: Creating Mathematics Daily Journal
- ❖ Lesson 3: Finding number Pattern
- ❖ Lesson 4: Counting Money
- ❖ Lesson 5: Recording the Growth of a Plant

Objectives of Lesson Plans

Grade 1 to 3 students will be able to

- Analyze and understand how both repeating and growing patterns are generated.
- Describe and make generalizations about geometric and numeric patterns.
- Discover what mathematics reveals about daily life situations.
- Model situations that involve the addition and subtraction of whole numbers, and the use of objects, pictures, and symbols.

- Recognize and extend patterns such as sequences of shapes and numeric patterns.
- Understand and communicate about daily life in order to solve problems.

Grade 4 to 6 students will be able to

- Analyze patterns and functions, using words, tables, and graphs.
- Discover what mathematics reveals about daily life situations.
- Express mathematical relationships using equations.
- Identify and describe situations with constant or varying rates of change and compare them.
- Understand and communicate about daily life in order to solve problems.
- Use symbolic algebra to represent situations and to solve problems.

Learning Activities

Learning activities for grades one to six will be designed coherently and consistently with the unit's student learning objectives. The activities include:

- Completing the written assignments.
- Completing mathematics assignments.
- Developing a unit portfolio.
- Keeping a daily journal.
- Participate in lesson introduction warm-ups.

- Participating in class reading.
- Taking daily quizzes.

Teaching Strategies

Teaching strategies for grades one to six include:

- Cooperative learning groups.
- Individual class work.
- Problem solving.
- Using manipulatives (calculators, computers, games, tools...).
- Whole class instruction and discussion.

Assessment

Assessment for grades one to six will be consistent with student learning objectives. Assessment includes:

- Classroom assignments.
- Communication proficiencies (reading, writing, listening, and speaking).
- Daily quizzes.
- Student portfolio.
- Unit test.

Instructional Materials

Instructional materials for grades one to six include:

- Calculator, rulers, papers, and an overhead projector.
- Internet resources and computer software.
- Textbook, *Elementary and Middle School Mathematics: Teaching Development, 3rd Edition.*
- Textbook, *Teaching and Learning Elementary and Middle School Mathematics, 3rd Edition.*

Grades 1-3

Unit 6: Algebra

Lesson 1

Introduction Activity for Lesson:

Discovering and Repeating Patterns

Learning Target: **Students will analyze, create, discover, and extend patterns of objects.**

Instructional Materials: **1. Cards**

2. Pencils

3. Worksheets

Activities:

1. Have students look at a pattern diagram. Then, ask students what they see in this diagram.
2. After the discussion, teach students the correct vocabulary terms such as pattern.
3. Hand out a set of cards to each group. Then ask each group to design and create their own patterns.
4. Each group will look at other groups' patterns. Ask each group to brainstorm and figure out what patterns the other groups used.

Worksheet

Name: _____

1. Find the patterns in this grid. Counting by threes.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Grades 1-3

Unit 6: Algebra

Lesson 2

Introduction Activity for Lesson:

Creating Mathematics Daily Journal

Learning Target: **Students will use mathematics method to record their daily life situations. Through writing in a journal, students will learn their daily patterns and also will learn numbering, adding, subtracting, and simple multiplying and dividing.**

Instructional Materials: **1. Daily Journals**

2. Pencils

3. Worksheets

Activities:

1. Ask students to record such questions as: "What did they eat today? Where did they go today?"
2. After recording for a week, students will know their daily habits or their routine work.
3. Ask students to count what things they did the most. Are there any patterns?

Worksheet: **Algebra *Problem Solving***

Name: _____

- The cost of 1 balloon is 2 dollars. 2 balloons are equal to 4 dollars. The cost of 6 balloons is 12 dollars.

    1. If Johnny wants to buy 8 balloons, how much will it cost?

    2. If Sue has 18 dollars, how many balloons can Sue buy?

You may draw or create a table to help you find the answers. You may use addition or multiplication. Show your answer.

1.

2.

Grades 4-6

Unit 6: Algebra

Lesson 3

Introduction Activity for Lesson:

Finding Number Pattern

Learning Target: **Recognize, create, and extend patterns of objects and numbers; write rules for functions based on a single operation.**

1. What two numbers come next in this number pattern? Show your work.

17 14 19 16 21 26 _____ _____

2. Look at the number pattern below.

2, 3, 6, 7, 14, 15, 30

- Explain the rule for this pattern. Use words, numbers, or pictures.

- Name the next two numbers in the pattern.

Unit 6: Algebra

Lesson 4

Introduction Activity for Lesson:

Counting Money

Learning Target: **Analyze mathematical situations and structures using algebraic symbols and express mathematical relationships using equations. Students will learn money units.**

Instructional Materials:

1. **Boxes**
2. **Chips in cents, dimes, quarters, dollars, ten dollars, and hundred dollars.**
3. **Pencils**
4. **Worksheets**

Activities:

1. Hand out chips and boxes to each student.
2. Ask if there are twenty dollars in side the box, how much money they need to add in order to make total two hundred dollars and seventy-eight cents. Ask students to practice this activity.
3. Teach using algebraic symbols to form equations.
4. Repeat the activities and ask students to form their equations.

Worksheet

Name: _____

Using symbolic algebra to represent situations and to solve problems.

1. If you save 24 dollars and 29 cents today, and you save a total of 100 dollars by the end of month, how much money do you save before today? Show your work.

2. If you start to save money on March 2 and you save 2 dollars and 50 cents every day, how much money do you save in the end of March? Show your work.

Unit 6: Algebra

Lesson 5

Introduction Activity for Lesson:

Recording the Growth of a Plant

Learning Target: **Analyze change in various contexts. Students will learn how to plot graphs and draw tables.**

Instructional Materials:

1. **Graph Papers**
2. **Pencils**
3. **Plants**
4. **Seeds**
5. **Worksheets**

Activities:

1. Show students different sizes of plants which are planted from day 0 to day 20.
2. Ask students to create a table showing the plants growth. Then, ask students to record the growth of a plant in days and height.
3. Show students how to plot a graph.
4. Ask students to plot the growth of a plant on the graph.
5. Show students your graph. Then, teach what the slope of a line represents. Display different patterns of change—change occurs at constant rate, increasing rate, or decreasing rate.

Worksheet

Name: _____

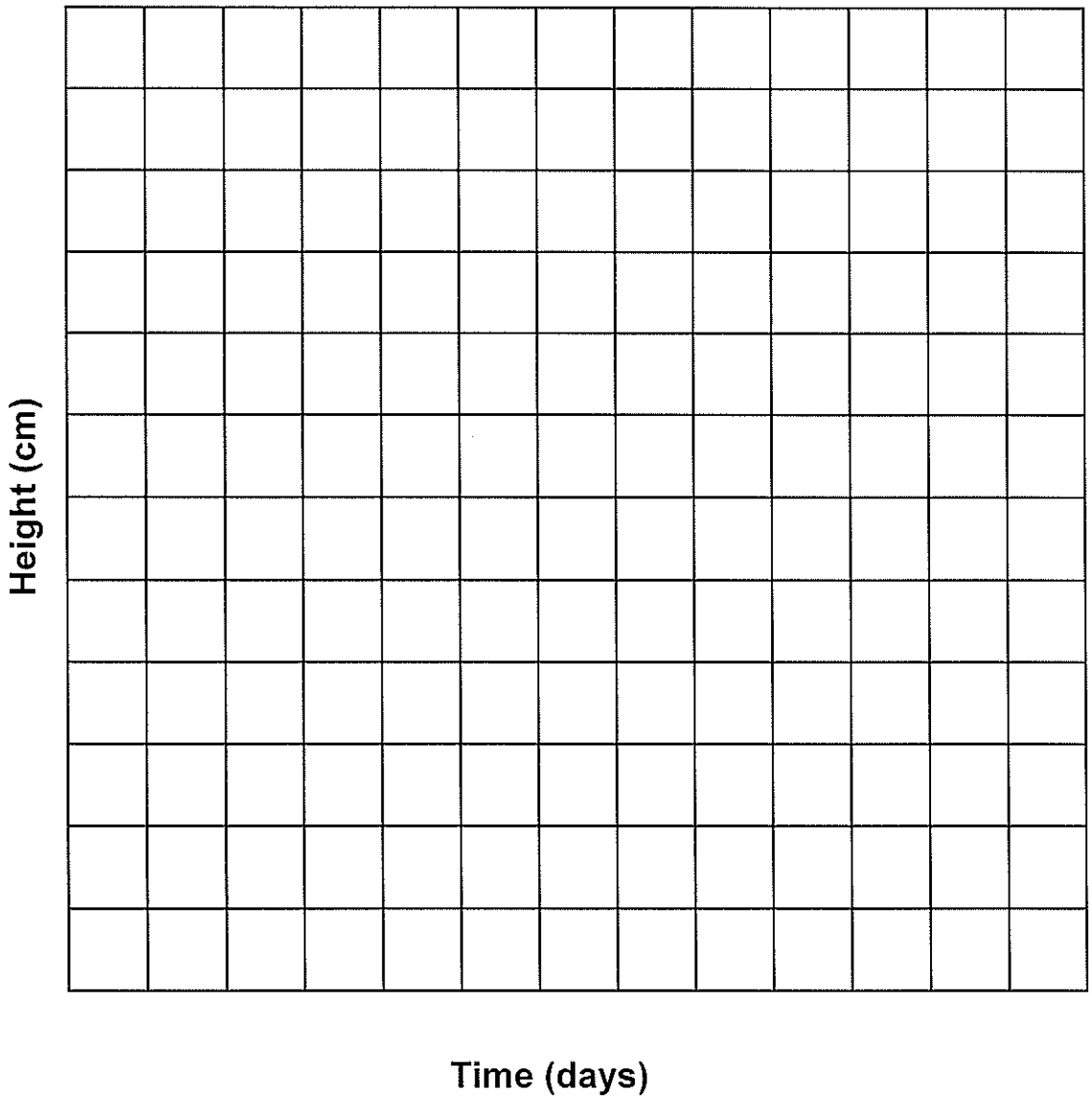
The data in the table below show the growth of a plant in time (days) and the growth of a plant in height (cm).

Time (days)	Height (cm)	Time (days)	Height (cm)
0	0	12	6
2	0	14	7
4	0	16	8.5
6	1	18	8.5
8	2	20	9
10	4		

Jonathan wants to present this information to the class in the form of a graph.

- Graph the data from the table on the grid.
- Create another table to show the change (cm) in growth by looking at graph.

Graph the data from the table on the grid below.



Create another table to show the change (cm) in growth by looking at graph

Unit 7

UNIT 7

DATA ANALYSIS AND PROBABILITY

Contents Page

DATA ANALYSIS AND PROBABILITY

Overview

The Data Analysis and Probability unit introduces students to simple data analyzing, to organizing and displaying data in appropriate forms, to using measures of central tendency to describe data, and to predicting to probability of outcomes. Each lesson is designed to target different learning areas from grades 1 to 3 and from grades 4 to 6:

- ❖ Lesson 1: Collecting Data
- ❖ Lesson 2: Tossing Coins
- ❖ Lesson 3: Using Measure of Center

Objectives of Lesson Plans

Grade 1 to 3 students will be able to

- Analyze simple data.
- Describe parts of the data and the set of data as whole to determine what the data shows.
- Discover what mathematics reveals about daily life situations.
- Gather data about themselves and their surroundings.
- Represent data using concrete objects, pictures, and graphs.

Grade 4 to 6 students will be able to

- Collect data using observations, surveys, and experiments.
- Describe the shape and important features of a set of data, and compare related data sets, with an emphasis on how the data are distributed.
- Discover what mathematics reveals about daily life situations.
- Find, use, and interpret measures of center and spread, including average, median, mean and mode.
- Predict the probability of outcomes of simple experiments and test the predictions.
- Propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.
- Recognize the differences in representing categorical and numerical data.

Learning Activities

Learning activities for grades one to six will be designed coherently and consistently with the unit's student learning objectives. The activities include:

- Completing the written assignments.
- Completing mathematics assignments.
- Developing a unit portfolio.
- Keeping a daily journal.
- Participating in lesson introduction warm-ups.

- Participating in class reading.
- Taking daily quizzes.

Teaching Strategies

Teaching strategies for grades one to six include:

- Cooperative learning groups.
- Individual class work.
- Problem solving.
- Using manipulatives (calculators, computers, games, tools...).
- Whole class instruction and discussion.

Assessment

Assessment for grades one to six will be consistent with student learning objectives. Assessment includes:

- Classroom assignments.
- Communication proficiencies (reading, writing, listening, and speaking).
- Daily quizzes.
- Student portfolio.
- Unit test.

Instructional Materials

Instructional materials for grades one to six include:

- Book, *Principles and Standards for School Mathematics.*
- Calculator, rulers, papers, and an overhead projector.
- Internet resources and computer software.
- Textbook, *Elementary and Middle School Mathematics: Teaching Development, 3rd Edition.*

Grades 1-3

Unit 7: Data Analysis and Probability

Lesson 1

Introduction Activity for Lesson:

Collecting Data

Learning Target: **Students will learn pose questions and gather data.**

Instructional Materials: **1. Three Beverage Cans**

2. Three Bowls

3. Legos

4. Pencils

5. Worksheets

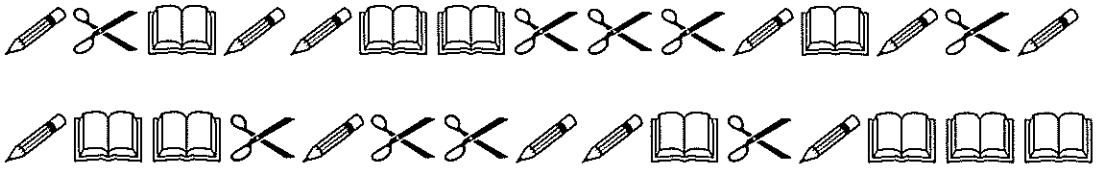
Activities:

1. The teacher will place three different beverage cans on the desk and put each bowl next to the can.
2. Have students vote for their favorite beverage by putting the lego into the bowls.
3. The teacher will lead students to count how many legos are in each bowl and write down the results.
4. Then, teach students to draw a table by showing the data they have collected.

Worksheet

Name: _____

1. Analyzing the data, record how many pencils, scissors, and books are here. Show your work in the table below.



Categories	Pencils	Scissors	Books
Quantities			

2. Each square represents 10 and each circle represents 5. Add up all squares and circles. How many are here?

●●□□□□●●●●●□●□□□●□●●□□●

Grades 4-6

Unit 7: Data Analysis and Probability

Lesson 2

Introduction Activity for Lesson:

Tossing Coins

Learning Target: **Predict, show, and evaluate the possible outcomes and probabilities of simple experiments and activities. Compare predictions to experimental results and make inferences from experimental results.**

Instructional Materials: **1. Coins**

2. Pencils

3. Worksheets

Activities:

1. Give each student three coins.
2. Ask students to toss one coin first. Ask them, what do they see?
3. Then, teach students the concept of tossing a coin. It will be either heads or tails, and the probability of tossing a coin is fifty percent heads and fifty percent tails.
4. This time ask students to toss two coins. Ask students to predict what outcomes will they see. How many possible outcomes will they get?
5. Ask students to form groups of four and toss three coins this time. Ask them how many possible outcomes they will get this time.

6. Ask students if there is a pattern. If there is, what is this pattern?

7. Teach students how to use equations to solve the problems.

Worksheet 1

Name: _____

There are a total of 12 balls in a bag.

❶ ❷ ❸ ❸

❶ ❶ ❸ ❷

❸ ❸ ❶ ❸

You are going to take one ball out of the bag without looking.

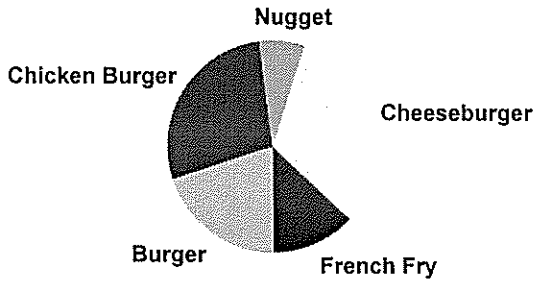
Which ball would you most likely draw? Show your work.

A.❶ B.❷ C.❸

Worksheet 2

Name: _____

About 100 children in this cafeteria were asked to choose their favorite food. The graph below shows the results of the survey.



List three things the graph tells you about their favorite food.

Grades 4-6

Unit 7: Data Analysis and Probability

Lesson 3

Introduction Activity for Lesson:

Using Measure of Center

Learning Target: **Develop the concepts of mode, median, and mean. Students will explore differences in reporting data using the mean, the median, and mode.**

Instructional Materials: **1. Pencils**

2. Worksheets

Instructions:

1. Teach students the concepts of mode, median, and mean.
2. Show the salaries of five professional baseball players to students. The salaries of five professional baseball players: $90,000, $100,000, $90,000, $180,000, and $550,000. The players are complaining about their salaries. They say that the mode of the salaries is $90,000 and that they deserve more money for all the games and practices.
3. Ask students to analyze this data, and find out what the median is.
4. The owners claim that the mean salary is $196,000, and that is plenty for any team. Ask students which side is correct. Is anyone lying? How can you explain the differences in the reports?

Worksheet 1

Name: _____

Baseball Players' Salary Data

1	2	3	4	5
$90,000	$100,000	$90,000	$150,000	$550,000

- Ask students to look at this salary data, and find out what the median is.

The owners claim that the mean salary is $196,000 and is plenty for any team. Ask students which side is correct. Is anyone lying? How can you explain the differences in the reports?

Worksheet 2

Name: _____

There are a total of 26 students taking the national mathematics examination. Two students scored 100, five students scored 75, twelve students scored 80, three students scored 88, four students scored 94, and the rest of the students scored 98.

- Draw a table to show the above data. This table should include the number of students and their scores.
- Find out the mode of this national mathematics examination.
- Find out the mean of this national mathematics examination.
- Find out the median of this national mathematics examination.

- **Draw a table to show the above data. This table should include the number of students and their scores.**

- **Find out the mode of this national mathematics examination.**

- **Find out the mean of this national mathematics examination.**

- **Find out the median of this national mathematics examination.**

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this project was to compare cross-cultural mathematics teaching in the elementary schools of East Asian and Western countries. In addition, a goal was to design and develop a common mathematics curriculum for elementary schools to use in both environments. To accomplish this, a review and comparison of current research and literature regarding current curriculum and mathematics education in Taiwan and the United States was conducted. Additionally, related information from selected sources was obtained and analyzed.

Conclusions

Conclusions reached as a result of this project were:

1. The need to improve children's mathematics skills is more essential than ever, in order for young children to live, work, and compete in this technologically advanced world.
2. The need to improve teachers' teaching methods is increasingly important due to the pressure for teachers to provide students with better learning opportunities so that students may achieve higher standards and higher performances.

3. Assessment practices need to change when different teaching methods are used.
4. The organization of mathematics curriculum will directly affect students' profound understanding of mathematics.
5. The cultural values of teaching mathematics between East Asian and Western countries are different. For example, Taiwan has an emphasis on teaching both the content and the process, whereas, Western countries are focused on teaching the process.
6. Educational reform demands educators find ways to design a coherent mathematics curriculum, to make that standard relevant to students, and to have students to set their own goals and achieve them.

Recommendations

As a result of this project, the following recommendations for Asian and American schools have been suggested:

1. Schools should help students to succeed in today's and tomorrow's advanced world by creating a mathematics curriculum that reflects on new practical applications, problem solving, reasoning, communicating, and relationship to practice.
2. Schools internationally need to create and follow a uniform curriculum.
3. A consistent and coherent mathematics curriculum is necessary to meet grade level standards.

4. Educators seeking to design, develop, and align a elementary mathematics curriculum should adapt and utilize materials from this project or undertake further research on this subject to meet their unique needs.
5. Teachers can integrate mathematics concepts throughout other subject areas and to daily life situations. Teachers can continuously point out where the mathematics are present until students can instantly connect to what they learn.

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