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ABSTRACT

This paper anlyzes the new elementary school mathematics curriculum materials being implemented in Taiwan. A list of objectives involving whole numbers is given for each semester in grades 1 through 5, with the time noted for each unit. Improved teaching methods, the use of the abacus and of technology, the roles of problem solving and estimation, and the importance of hands-on experiences are each discussed. (MNS)

AN OVERVIEW OF BASIC FACTS, COMPUTATION WITH WHOLE NUMBERS, AND ESTIMATION IN THE ELEMENTARY SCHOOL OF TAIWAN, REPUBLIC OF CHINA*

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According to the Constitution of the Republic of China, all children from six to twelve years of age are required to receive free elementary education. The aims of this education are physical and moral development of the children and the teaching of ethical principles and good behavior. All of this training is to prepare them to become good citizens.

The development of a new curriculum in science and mathematics for the elementary schools started in 1978. It was implemented nationwide in the first grade in September of that year. The new curriculum in the second grade commenced in 1979 and the new curriculum in the third grade began in 1980. This "one year at a time" curriculum reform was fully implemented by September of 1983 when all grades in the elementary schools were using the new science and mathematics curriculum (Tsui, 1983).

Thousands of hours of effort by highly qualified mathematics teachers and education

specialists were put into the development of the new mathematics curriculum material. This new material is not only attractive and well-organized, it is also well-illustrated, easy to understand, interesting and contains less content than the old material.

This new package of material provides a valuable resource for teachers. Compared to the new material, the old material over-emphasized content and dril. The teachers presented material on the chalkboard and required students to memorize rules of computation in order to apply the rules to the hundreds of problems they must finish for homework every night.

The new curriculum movement includes teachers' re-training, new textbooks, workbooks and laboratory manuals, audio-visual aids, and suggested teaching methods. It takes long-range planning and hard work for teachers to adjust to the new curriculum.

In Taiwan, R.O.C., the second six years of curriculum reform is currently underway. Continuous coordination, implementation, evaluation, and redefinition has promoted the success

of the reform movement. This movement will provide up-to-date knowledge and new teaching techniques.

One of the purposes of this new mathematics curriculum is to aid the student in developing an understanding of mathematics. There are many mathematical ideas that are never fully understood by students because of an early introduction to a supposedly "best way" or abstract rule. This occurs when a teacher neglects to let the students learn various methods of getting solutions. For example, a student should have many opportunities to multiply whole numbers using drawings, diagrams, counting rods, number lines, and hands-on activities in the classroom before he or she comes into contact with the multiplication sign. It is very important that children see mathematical ideas in a variety of contexts.

How can we help students think mathematically and understand mathematical ideas involving their surrounding environment when they are being taught in a very boring, plodding, and rote manner? Students learn their lessons under the same old format and in the same old

manner. This approach to teaching, which is used by most of the teachers in Taiwan, creates disinterest in the learning of mathematics. This is another reason for the implementation of the new curriculum movement in Taiwan. Hopefully, this new material will provide teachers fresh ideas, new teaching strategies, and interesting techniques for stimulating students' interests in learning mathematics.

Children learn to count at a very early age. They like to know how many pieces of candy belorgs to them or how many toys they have as compared to their friends. The most readily available instruments they have to count on are their fingers.

In Taiwan, teaching activities involving basic facts, computations of whole numbers and estimation span from first to fifth grade. The following is a description of topics involving whole numbers in each grade level (National Institute of Computation & Translation--Ministry of Education, 1982):

First Grade, First Semester--

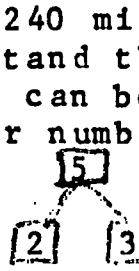
1st unit activities (200 minutes)
-be able to recognize the whole numbers 1-10.

-be able to count the number of same objects.

2nd unit activities (160 minutes)
-be able to read and write the whole numbers from 0-10 and know the meaning of 0.
-be able to recognize the quantities of different objects.

3rd unit activities (200 minutes)
-be able to compare the whole numbers between 0-10.
-be able to order the whole numbers 0-10.
-be able to compare two numbers as to greater than or less than.

4th unit activities (160 minutes)
-be able to recognize the shape of objects and tell the quantities of same shape objects.
-be able to understand surfaces such as the surface of a cube and surface of a ball.
-be able to recognize triangles, rectangles, squares, and cubes.

5th unit activities (240 minutes)
-be able to understand that a whole number from 0 through 10 can be rewritten as the sum of two smaller numbers. For example, 4=3+1, 7=5+2, and 

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-be able to use the game, "Toss the Ring", (tossing 5 rings onto a pole) to record the results of how many rung the pole and how many missed it.

6th unit activities (80 minutes)
-be able to recognize amounts of money up to ten dollars.
-be able to add money to a total of ten dollars.

7th unit activities (280 minutes)
-be able to use "+" and "=" to represent a statement. For example, three plus two is equal to five (oral statement) means 3+2=5.

8th unit activities (280 minutes)
-be able to use "-" and "=" to represent a statement. For example, five minus three

is equal to two (oral statement) means 5-3=2.

9th unit activities (200 minutes)
-be able to count from 11 to 20 and recognize numbers of objects.
-be able to match two equivalent sets of pictures in a one-to-one correspondence.
-be able to associate a row of objects with an ordinal number from first to tenth.

10th unit activities (120 minutes)
-be able to read time on a clock.
-be able to read the daily schedule.

First Grade, Second Semester--

1st unit activities (240 minutes)
-be able to count and write up to 100.
-be able to recognize ones and tens place.
-be able to arrange numbers in order and compare them.

2nd unit activities (160 minutes)
-be able to add by tens.
-be able to subtract by tens.

3rd unit activities (160 minutes)
-be able to add or subtract three numerals. For example, 4+2+3=9 and 5+2-3=4.
-be able to fill missing values in a sequence of numbers by ones, twos, fives, and tens. For example, 1,_,_,4,_, and 6,_,_,_,14, and 20,__,30,__,40, and 60,70,__,__,100.

4th unit activities (120 minutes)
-be able to know how many days are in a week.
-be able to read the calendar.
-be able to know how many specific days are in a certain month. For example, four Sundays in April, 1980.

5th unit activities (120
-be able to understand the concept of length: long, short or equal length.
-be able to measure the lengths of desks, boxes, books, etc. using non-standard measurement.

6th unit activities (240 minutes)

-be able to add two-digit numbers (whole numbers) to one-digit numbers. For example, 23+7=30.

7th unit activities (280 minutes)
-be able to subtract one-digit numbers from two-digit numbers (whole numbers). For example, 30-7=23.

8th unit activities (160 minutes)
-be able to draw or construct figures such as squares, triangles

9th unit activities (120 minutes)
-be able to understand the properties of 0 such as the addition of 0 and the subtraction of 0.

Second Grade, First Semester--

1st unit activities (200 minutes)
-be able to add two-digit numbers (whole numbers). For example, 23+37=60.

2nd unit activities (120 minutes)
-be able to compare volumes of containers. For example, how many cups of water fill the two different glasses?

3rd unit activities (240 minutes)
-be able to subtract two-digit numbers (whole numbers). For example, 60-23=37.

4th unit activities (160 minutes)
-be able to measure the length of desks or any plane surface objects using standard measurement.

5th unit activities (160 minutes)
-be able to read hours, minutes, and seconds on a clock.

6th unit activities (120 minutes)
-be able to record the results of the game, "Basketball", i.e. how many shots went in the hoop and how many shots did not go into the hoop. Also, compare to see who received the highest score.

7th unit activities (200 minutes)

-be able to read and write whole numbers to 1000.
-be able to identify the ones, tens, and hundreds place in a three-digit number.

8th unit activities (200 minutes)
-be able to add three numbers. For example, 5+2+3=10.

9th unit activities (300 minutes)
-be able to draw a straight line.
-be able to identify the components of triangles, squares, and rectangles.

Second Grade, Second Semester--

1st unit activities (200 minutes)
-be able to add three-digit numbers. For example, 315+122=437.

2nd unit activities (160 minutes)
-be able to recognize and compare the size of cubes and rectangular solids.
-be able to describe number of sides of a cube or a rectangular solid, or number of the same shapes and same sizes.

3rd unit activities (200 minutes)
-be able to subtract three-digit numbers. For example, 437-315=122.

4th unit activities (160 minutes)
-be able to divide objects or numbers into equal parts.

5th unit activities (200 minutes)
-be able to perform multiplication by twos up to 2x9 and by fives up to 5x9.

6th unit activities (200 minutes)
-be able to perform multiplication by fours up to 4x9 and by eights up to 8x9.

7th unit activities (160 minutes)
-be able to perform multiplication by threes up to 3x9 and by sixes up to 6x9.

8th unit activities (120 minutes)
-be able to perform multiplication by nines up to 9x9.

9th unit activities (240 minutes)
-be able to perform multiplication by sevens up to 7x9.
-be able to construct a multiplication table up to 9x9.

Third Grade, First Semester--

1st unit activities (240 minutes)
-be able to multiply any two numbers.
-be able to multiply by 0.

2nd unit activities (240 minutes)
-be able to divide whole numbers. For example, 10/5=2, 5/5=1, 0/5=0.

3rd unit activities (200 minutes)
-be able to understand the number line.
-be able to add or subtract two-digit numbers.

4th unit activities (200 minutes)
-be able to count numbers up to 10,000.
-be able to perform the following multiplications: 10x100=1000, 10x10=100, and 10x1000=10,000.

5th unit activities (200 minutes)
-be able to add four-digit numbers. For example, 3124+5167=8291.

6th unit activities (240 minutes)
-be able to subtract four-digit numbers. For example, 2645-2532=113.

7th unit activities (280 minutes)
-be able to divide numbers with different numbers of digits.

8th unit activities (200 minutes)
-be able to identify the centers, radii, diameters, and circumferences of circles.
-be able to use compasses and rulers to construct circles.

9th unit activities (160 minutes)
-be able to obtain information from bar graphs.

Third Grade, Second Semester--

1st unit activities (320 minutes)
-be able to multiply whole numbers. For

example, a two-digit number by a one-digit number (32x7)or a three-digit number by a two-digit number (473x59).

2nd unit activities (240 minutes)
-be able to determine the weight of an object in kilograms.

3rd unit activities (200 minutes)
-be able to measure the lengths of the parts of different figures.
-be able to convert between meters, kilometers, and millimeters. For example, 1 meter (m) = 100 millimeters (mm), 1 kilometer (km) = 1000 meters (m), etc.

4th unit activities (360 minutes)
-be able to divide whole numbers. For example, 6/3=2, 60/3=20, 952/4=238.

5th unit activities (160 minutes)
-be able to recognize triangles, angles, equilateral triangles, and isosceles triangles.
-be able to compare angles by size.

6th unit activities (320 minutes)
-be able to multiply whole numbers. For example, 10x10=100, 10x90=900, 100x7=700, and 54x37=1998.

7th unit activities (200 minutes)
-be able to convert between hours, minutes, and seconds. For example, 1 day=24 hours, 1 hour=60 minutes, and 1 minute=60 seconds.
-be able to tell time.

Fourth Grade, First Semester--

1st unit activities (320 minutes)
-be able to divide whole numbers. For example, 80/27=2R26, 1R48.

2nd unit activities (200 minutes)
-be able to use the abacus for addition of whole numbers.

3rd unit activities (240 minutes)
-be able to measure angles.
-be able to use compasses and rulers.

-be able to make (using paper) equilateral triangles.

4th unit activities (120 minutes)
-be able to use the abacus for subtraction of whole numbers.

5th unit activities (280 minutes)
-be able to recognize whole numbers larger than 10,000.

6th unit activities (120 minutes)
-be able to subtract and add using the abacus.

7th unit activities (240 minutes)
-be able to understand the meanings of and to draw perpendicular and parallel lines.
-be able to understand the meanings of and to draw isosceles trapezoids, parallelgrams, rectangles, squares, rhombuses, and equilateral triangles.
-be able to construct (using paper) the above figures.

8th unit activities (80 minutes)
-be able to use the whole numbers larger than 10,000.

9th unit activities (200 minutes)
-be able to work word problems consisting of computations of addition, subtraction, division, and multiplication.
-be able to use parentheses. For example, (12-2)/5=2 and 9-(4x3)+10=7.

10th unit activities (280 minutes)
-be able to find the areas of rectangles and squares and compare them.

Fourth Grade, Second Semester--

1st unit activities (60 minutes)
-be able to add and subtract larger numbers using the abacus.

2nd unit activities (320 minutes)
-be able to recognize the components of cubes and other solid figures.

3rd unit activities (240 minutes)
-be able to compute the volume of cubes and spheres.

4th unit activities (240 minutes)
-be able to multiply and divide three-digit numbers by three-digit numbers. For example, 600/200=3

5th unit activities (120 minutes)
-be able to use the abacus to add and subtract several digit numbers.

6th unit activities (120 minutes)
-be able to collect data, analyze it, and present the results in a line or bar graph.
-be able to read results from a line or bar graph.

Fifth Grade, First Semester--

1st unit activities (240 minutes)
-be able to factor whole numbers.
-be able to determine the least common multiple and the largest common divisor.
-be able to identify prime numbers and composite numbers.

2nd unit activities (240 minutes)
-be able to determine multiples, common multiples, and least common multiples.

3rd unit activities (120 minutes)
-be able to use the abacus for addition and subtraction of large numbers or for many numbers. For example, 4500+5593+8070+428=18,591 and 94-87+93-56=44

4th unit activities (240 minutes)
-be able to see the relationships of triangles.
-be able to use the fact that the sum of interior angles of a triangle equals 180°.

5th unit activities (280 minutes)
-be able to estimate with whole numbers.
-be able to understand the meaning of above, below, less than, greater than, approximate,

and average. For example, "What is the population of this area? Approximately twenty thousand." and "The average height of John, Mark, and Peter is about 6 feet."

6th unit activities (160 minutes)
-be able to multiply or divide mentally.

Fifth Grade, Second Semester--

1st unit activities (320 minutes)
-be able to find the average lengths and heights of objects.
-be able to recognize the relationships between whole numbers and understand ordered pairs.
-be able to graph information.
-be able to compute time using whole numbers and work word problems related to time.

In Taiwan, Republic of China, the elementary school teachers have received the best available teacher-training education (five years of formal training). The mathematics backgrounds of the teachers is far better than the mathematics backgrounds of the teachers in the United States (Chang, 1984). Most of the teachers are willing to learn and are eager to participate in in-service training and meet the challenge of using new teaching techniques.

In the past, elementary mathematics was often reduced to rote computation and mere memorization of addition and multiplication

facts that had no connection with the children's world. Due to the technological advancements of this modern age, many devices have been invented to help children learn. Mere rote memorization and drill computation won't be challenging enough for students to learn mathematics. Teachers will see that their responsibilities include fostering creativity and developing positive attitudes toward mathematics.

A major block to learning mathematics in elementary school is a general fear of the subject. Most students in elementary school feel that rote memorization and computation by boring procedures (such as long division) are a waste of their time. Furthermore, these methods create confusion. This is another factor which causes students to dislike mathematics.

Currently, the third year of the second six-year curriculum reform is underway. All elementary school teachers received at least seven weeks of intensive training in new teaching methods and content.

The role of mathematics on the eve of a new century will change. Mathematics will increase

in value and usefulness. Mathematical literacy will be required for every citizen in order for him/her to maintain a minimum standard of living. In the position paper on basic mathematical skills written by the United States National Council of Supervisors of Mathematics on January 7, 1977, the definition of basic skills was rewritten and the number of skills was expanded (NCSM, 1977). The Council that basic skills must include more than computations because the present technological society requires use of such skills as estimating. organizing, measuring, predicting, and applying mathematics to everyday situations. Furthermore, they emphasized that the explosive increase in the amount of quantitative data and the availability of computers and calculators demands a redefining of the priorities for basic mathematical skills. How to cope with rapid changes in technological advancement should be the most important issue in today's education.

In the past, rote memorization and computation were used to develop ideas and skills in elementary school mathematics. With the completion

of the first six-year curriculum reform, most teachers in Taiwan will be able to use the new materials accompanying the new techniques. They will be able to develop children's mathematical thinking and show them how to apply mathematical ideas in daily activities. Teachers will understand that if they don't actively seek new knowledge, they will be unable to teach children.

One of the unique features in the Chinese elementary school is the development of the skill needed to use the abacus. This skill is developed in the fourth grade. The activities involving the abacus train the students to do various whole-number computations. They provide tremendous opportunities for students to think and learn. They also provide a lot of fun.

Some of the elementary schools are beginning to acquire microcomputers. Most of the elementary school students already know how to use calculators. As teachers of mathematics, we have to not only continue to teach students basic skills, we also need to readjust our thinking about the best way to help children

learn. We also need to emphasize problem solving in the elementary school. Perhaps teachers could introduce problem-solving situations at the beginning, or in the middle, of each lesson. This could create a more interesting approach to problem solving. It is certainly better than using the problem-solving lessons at the end of the unit as a practice of the unit's work. Children will have difficulty associating previous learning with the problems at the end of the unit. Teachers could also use problem-solving activities that are of interest to children. For example, during the second semester, a simple survey of the little league baseball teams would generate a lot of interest. Teachers need ideas to develop interesting environments such as bulletin boards for displaying creative, new problems or challenging puzzles for students who enjoy working them.

Estimations occur quite frequently in our daily life. However, in the early grades, computation of whole numbers is regarded as the most important skill for the students to learn. Most teachers realize that the development of

meaning from whatever they teach, with emphasis on estimation and application of whole numbers to the real world, will be the crucial point in the teaching of mathematics. It is not until the fifth grade do teachers formally introduce estimation. Most teachers are reluctant to spend a lot of time on this topic because drill and computation will benefit the students more in the coming years when they participate in entrance examinations for advancement. Thus, the problems on estimation, for which students must quickly arrive at estimated answers, are considered a less important skill.

In general, the elementary school students in Taiwan have a reasonable mastery of computational skills, especially those that involve whole numbers. However, a lot of the students in the early grade levels still have a severe deficiency in areas such as problem solving, measurement, and estimation.

We need to give students hands-on experiences during their learning. We need to build understandings which can be acquired through skills gained in previous learning. The success of mathematics teaching at the elementary school

levels is entirely dependent upon the effectiveness of the individual teachers. Neglect of real-life experiences will contribute to students' learning difficulties and negative attitude toward mathematics.

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