Everyday Math: What is it and how does it work?

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As the saying goes, "the only thing that stays the same is change", (anonymous). Change is good in most cases, for Everyday Math change is controversial. Everyday Math has been the subject of controversy since its inception particularly at the elementary level. Curiosity as to the nature of this controversy has given me the opportunity to see the Everyday Math program first hand. As a teacher at the high school level, it would be advantageous to me to study how a student develops certain mathematical concepts as early as kindergarten through the later elementary years in order to better understand what their thinking should be by the time they reach high school.

During the course of this study, focus will be on particular topics as they are developed from primary levels to intermediate levels and ultimately how they relate at the secondary level. Another focal point will be analyzing certain algorithms using Everyday Math techniques verses the traditional process and how children learn them. Finally, because of the controversy surrounding Everyday Math, an attempt will be made to analyze the effectiveness of the curriculum by considering different variables, which affect the learning process of children. Research into this curriculum has lead me to more questions than answers. Is this program better than any other program available? Is it conducive to all children and their different learning styles? Are teachers buying into it? Are teachers being adequately prepared to teach it? Are parents buying into it? This study is not an attempt to judge the Everyday Math program, but rather to understand its proposed rationale, techniques, and more importantly, its effectiveness.

Everyday Math was conceived in the 1980s through the efforts of the University of Chicago School Mathematics Project in an attempt to revolutionize mathematical learning in grades K-12 in the United States. Everyday Math is the result of a research study based on the premise that children learn and retain more information at an early age and learn it more intuitively rather than under the guidance of teacher instruction. The emphasis of Everyday Math is problem solving with everyday applications as well as adequate use of technology. The use of the traditional rote, drill, and practice are no longer the focus of attention. The belief is by exposing children at an early age to alternate methods of learning, which involves significant emphasis on everyday applications, student expectation is heightened and thus enables them to relate better to a broad range of topics and applications. I believe math should be an enjoyable, engaging, simple, but essential part of everyday life.

Learning math should relate to life experiences thereby making it meaningful. Everyday math is an attempt to do all of these things but not without shortcomings and controversy.

Children have varying degrees of life experiences by nature of their diversity whether it is due to their cultural or socio-economic background, which could be another motivating factor behind this mathematical transformation. Research shows that children from poor socio-economic backgrounds do poorly on standardized tests. This lack of success could be directly related to certain inherent biases within the test based on their life experiences. The biases are evident across the content areas. Just recently my five year old great nephew was working on a homework assignment which involved identifying words which begin with the letter "V''. Several pictures of different items were given. Although he correctly identified most of the words which began with the letter "V'', there were two words he was not able to identify, vase and vine. When asked why he did not circle those items, his response was "because that's a jar and that's a tree." Examples of mathematical biases could be "Xavier plays croquet every other day. His sister Anastasia plays croquet every third day. If they played together today, when will they play again?", which is a cultural bias. At the high school level, a question may read, "A guy wire attached to the top of an antenna is anchored at a point on the ground 10 meters from the antenna's base. If the wire makes an angle of 55 degrees with the ground, how high is the antenna?", which if students don't know what a guy wire is, and most don't, they could not answer the question.

How a question is asked can also be a dilemma for some children, particularly at a young age. Rephrasing the question without symbolism might make the question more familiar. For example, using symbols at an early age such as ½ of 4 or 4/2 may not be familiar to the child, but saying the words " give me half of your marbles", would elicit a successful outcome. Even at an older age, how a question is asked could determine whether an outcome is successful particularly if there is a lack of proper vocabulary. For example, "find a regression model given the following data". If the student does not know the meaning of regression, chances are a successful outcome would not be obtained.

Until recently, there was no real connection between what was taught and what was asked on standardized tests. Teachers were and in some cases still are comfortable in their rote, drill, and practice teaching. Everyday Math attempts to narrow this gap. Students are now being taught a broader range of topics at an early age. We as teachers should no longer be satisfied with just the correct answer, but more importantly how that answer was obtained and what it means in terms of the problem. When I was in school, we were given several of the same type of problems whether they were addition, subtraction, multiplication, or division. There was little, if any, conceptual development. We practiced solving them one particular way, over and over until we knew the process well enough to get a correct answer. Everyday Math introduces children to a variety of alternative algorithms in its curriculum, which in some cases enables students to better understand the mathematics involved. Traditionally, adding two and three digit numbers were performed from right to left with some problems involving "carrying over "(See figure 1). Students would add 3 and 8, bring down a 1 and carry a 1, add, 1, 2, and 7, bring down the 0, carry the 1, and so on. This process provides no real meaning in terms of the math. Everyday Math uses one of many algorithms called partial sums (See figure 2). Partial sums are performed left to right, which is consistent with how we read numbers, and for that matter words. In this algorithm, students can see and therefore understand place value because in reality, they are not adding 3 and 1, but rather 300 and 100. They see and therefore know that they are in fact adding hundreds, tens, and ones, even though there is still carry over. Students should have some understanding of place value before attempting addition and subtraction. They should understand that they are not just adding digits. Digits are not numbers. Digits get their values from where they are placed in our place value system, which is based on sets or powers of ten. Several of the algorithms used in Everyday Math uses this notion of expanded notation, which in and of it is not a new concept, but traditionally was not used properly.

Some of the alternative algorithms found in the Everyday Math curriculum are too intricate for students to grasp and assumes certain prior knowledge such as lattice multiplication (See figure 3). Here the students must first draw a lattice grid, which could be a chore by itself. The grid could be a square grid if multiplying a two-digit number by a two digit (or 3x3, etc.) or a rectangular grid to multiplying a three digit by a two digit number. Next they must put the digits for each number in their proper place, the first number horizontally across the top, the second number vertically down the side. The "weave" takes place by multiplying each number on the side by each number at the top, being sure to write single digit answers with appropriate zeros in front. Finally, each number inside the diagonal is added and listed at the bottom of the diagonal. The answer is read from left to right. The problem with this algorithm is it takes too long to process, let alone set up, and does not allow for conceptual understanding of the meaning of multiplication based on equal sets. It is also visually confusing.

Students are apparently taught place value before being taught addition and subtraction. My question is to what extent are students required to know place value, in terms of mastery, before attempting addition and subtraction? Everyday Math uses what is called a "spiral" effect. Students move quickly through a wide range of topics, but the topics are revisited several times, usually in different contexts, throughout the course and grade levels. Mastery is therefore not necessary initially. Because of this, students are assessed gradually using three stages of development, which are beginning, developing, and proficient. Beginning students show little evidence of understanding the concept or skill and need assistance to complete a task. Developing students show some understanding but still have not mastered it. The proficient student is able to apply the skill or concept without assistance thereby showing their understanding and subsequent mastery. This differs somewhat from the more traditional curriculum, which concentrates on isolated concepts until mastery, then the concept may not be revisited until the next grade level.

A strong attribute of the Everyday Math curriculum is introducing higher-level concepts as early as Kindergarten and increasing their knowledge on the topic at each grade level. Students at this level are introduced to the concept of data collection by making simple graphs showing how many classmates have a birthday each month. By the time they reach fifth grade, students can demonstrate the same skills by designing a survey, administering it to their classmates, graphing, and interpreting the results. This basic knowledge will eventually lead them to understanding and using regressions at the secondary level.

Problem solving at the high school level involves choosing a proper model, which represents the problem to be solved. Different models represent different situations. A model can be in the form of an equation (symbolic), pictorial (graph), numerical (table of values) and for younger children, concrete (manipulative). At the high school level, quadratic equations may model problems involving area or the height of an object over time. Exponential equations model growth such as population, bacteria, etc. or decay, as in radioactive substances. Linear equations can model a variety of situations. Students at the high school level are expected to organize data to find a proper model to use in order to predict future outcomes or to solve problems involving the data. A regression model brings together the use of data, number theory through patterns, graphing skills, and the use of technology within the framework of standards set by the national (NCTM), state (Pennsylvania Department of Education), and local (Pittsburgh Board of Education) administrations. The Everyday Math curriculum introduces students to these concepts at a very young age, albeit informally, and reinforces them at every grade level utilizing a variety of activities. Students at this young age are not familiar with the technical names such as regression, linear, quadratic, nor should they be. What's important is they are beginning to learn and hopefully understand skills and concepts, which would provide the basic knowledge, needed at higher levels of learning and in life as well.

As children grow to become productive citizens of society, it is important that they understand and are properly informed to make certain decisions about situations they may encounter professionally and/or socially. The use of data to make predictions and ultimately decisions based on the data is an important mathematical concept to study, even at an early age. Everyday Math introduces data collections as early as kindergarten at a very basic level. Keeping in line with the philosophy of Everyday Math, the students collect data on things that are of interest to them in an attempt to motivate learning. In one instance a group of kindergartners thought it would be useful to survey the class to see how many of them knew how to tie their own shoes and how many of them still needed the help of the teacher. They, the students, thought it would be a good idea to use this information to pair up students who can tie their own shoes with students who can't. The result of the activity was students creating a survey, displaying the data collected and finally finding a solution to a class problem. This is a simple, but good activity for an early introduction to data. Basic graphs such as line plots and bar graphs are used to display the data. At this age, students only need to be able to examine and explain basic things. Other activities at this age for data collection would be surveying birthdays, ages, height, or combinations of them. During the course of these activities in data collection students are reinforcing number counting and measurements.

Data can be organized in various ways; bar graphs, line graphs, circle graphs, etc. Students need to organize data to visualize patterns, which may occur. It is these patterns that help in the decision making process. Most mathematics is based on patterns. Patterns may be visual initially and lead to number patterns. As students progress through their study of data, they recognize patterns and are able to make certain predictions or decisions based on that data. At the higher level, students begin to make more sense of what those patterns mean in terms of the real world. Because of their experience at an early age, it is hoped that they enter this higher level with the appropriate understanding of these basic concepts to help in their understanding of different functions by observing various patterns. Two types of patterns are studied throughout the elementary level and revisited at each level, sequences and functions. One activity used to reinforce skills in their learning of sequences is the Frames-and-Arrows Diagrams, which consist of two parts, the rule (or pattern), and the sequence number. The frames are a series of geometric shapes such as rectangles, circles, or triangles. Different shapes are used so students know the number pattern is the emphasis, not the shapes. These shapes run horizontally while the arrows are used to indicate the direction of the pattern (see figure 4). The frames contain a number in the sequence and each arrow represents the rule that determines what number goes into the next frame. Skills are reinforced by variations in the diagram. Information is usually left out for the student to find the necessary information based on the pattern. One diagram may have one or more empty frames and students must fill in the numbers. Another diagram may have all the frames filled in and students are expected to find the rule. Diagrams can also have a combination of missing items such as the rule and a frame (see figure 5). Students are further challenged when given two sets of rules and frames, but they must fill in the arrows to the proper numbers (see figure 6).

The Frames-and-Arrows Diagrams concept is carried over to 1st and 2nd grades but instead of using the geometric shapes as the frames, students are introduced to number lines. Students are given a number line with a sequence of blanks to be filled in to label the tick marks. The tick marks represent intervals or scales, which in terms of the diagram would be the rule on a graph (see figure 7). This introduction will be useful as they move on to higher levels of math and their studies of various graphs, particularly graphing by hand, which is used extensively in Algebra 1. Being able to determine an appropriate scale is important in graphing by hand as well as using a graphing calculator. Extensions of this skill can be allowing students to choose any scale they want given one tick mark. In addition to learning about sequences, students reinforce basic counting up and counting down skills.

Third grade introduces various scales by expanding the number line to include larger whole numbers, fractions, decimals, and negative numbers (see figure 8). Frames-and-Arrows is a good activity to help students understand number patterns at this age. In addition to studying scales and intervals used for numbering axes at the 3rd grade level, emphasis is on the title and labels for the axes (number lines representing the coordinate graph) which is in line with the 5 graphing guidelines discussed in Algebra 1; title, labels, uniform scale, appropriate scale, and point plotting. Discussion about scales being too large or too small causing distorted graphs is also topics. Learning about these topics is valuable in understanding graphing equations at the higher level. Sequences also introduce students to the concept of recursiveness where the next number in the pattern is found. At the higher-level students realize finding the next number in a pattern might become cumbersome if you need to find a larger number in the sequence. They are therefore introduced to function rules, which, if a pattern is found, allow you to find any number in the pattern. Young children are exposed to functions as a pairing of numbers in two sets. These pairings are related by a rule.

At the kindergarten level, Everyday Math again uses an activity of interest to the children such as determining whether they belong to a certain group or not. For example, children with laces for shoe closures belong to the group while children with buckles or some other closure do not belong. In grades one through three, the idea is extended to include numbers and rules for determining which numbers belong to specific sets of numbers which leads to incorporating sets of number pairs in which the numbers in each pair are related according to a rule. Students use what they call "function machines" to visualize how a rule associates each input value with an output value. Through fourth grade, a table of values is then used to organize the ordered pairs. What's My Rule? is the activity used to develop this concept (see figure 9). In this activity, students are given two of the three parts and therefore must find the third part. Variations of this activity can also be used as in the Frames-and-Arrows Diagrams.

Because Everyday Math uses the different models for representing a problem early on, by the time students get to grades four through six, they should have enough understanding of patterns with the help of the given activities. In fifth grade, they start making the connection between rules, tables, and graphs, which will follow them through high school. Everyday Math provides several activities to solidify the connection. Given a graph, students will be able to generate a table of values. The graph may consist of a set of discrete points (see figure 10) or a continuous line (see figure 11). Students can practice generating a table of values from a given equation by substituting values for x and solving for the corresponding y. Another activity involves using data by identifying the ordered pairs from a table, plotting the ordered pairs on a coordinate graph and connecting the dots. Students will also be able to answer specific questions based on the pattern shown on the graph. They begin to reinforce the relationship between the ordered pairs in context by using applications, which is a focus at the high school level. The plotting of points without connecting the points is a graph known as a scatterplot, which plays an integral part in identifying regressions used in problem solving. Lastly, fifth graders work on what are called "mystery graphs. " Using a coordinate graph, they are to identify which graphs best explains given behaviors. This activity will help students understand the different attributes of different functions and what distinguishes one from another which will ultimately help in deciding which function to use to solve problems involving regressions at the high school level. The Everyday Math curriculum, if taught properly, will provide students with a solid understanding of relationships between ordered pairs as well as connections between rules, tables, and graphs which should carry over into problem solving and the use of regressions to help solve specific problems of the real world.

In speaking with teachers currently teaching this curriculum, both inside and outside the seminar, one of the concerns of this program is lack of proper teacher development. Some teachers are forced to change their pedagogy to include the broader range of topics. This raises an issue of certification. Elementary teachers are certified across content areas, meaning they teach all subjects not just math. Because of this, many teachers may not have the knowledge base needed to teach the type of curriculum found in Everyday Math. Another concern among teachers is the lack of flexibility within the curriculum. Some teachers believe not enough time is given for students to "develop" a concept or skill because they, the teachers, are expected to keep moving quickly through topics. This is a valid point because not all children learn at the same pace. Slower learners become frustrated when they are not able to make the "discovery" or connection which could be due to lack of time. Everyday Math would argue using the reasoning behind the spiral effect," it's ok if they don't understand it now, they'll see it again…" Students at any age need to be given the opportunity to learn. They need to be able to absorb, digest, and practice concepts or skills to reinforce their understanding which raises the questions "How long is long enough? and Does Everyday Math afford every child the 'opportunity" to learn?" Along with the fast pace, teachers are forced to follow a particular sequence in the book allowing little flexibility even in terms of their professional judgement. After a while teachers know or should know the capabilities of their students. We know what works for what student and what doesn't. We should be allowed to supplement accordingly based on the need of the student, who after all, is or at least should be our primary concern. I believe we as teachers, underestimate the ability of children. Just because Johnny doesn't know basic facts does not necessarily mean Johnny doesn't understand topics on a conceptual level or isn't capable of logic and reasoning. This is not to say students should not know basic facts because the bottom line is they should. The truth of the matter is they didn't know their basic facts, generally speaking, before Everyday Math came about, so why not move on to something else while still incorporating drill and practice of the basic facts. The everyday routines within the curriculum include games, which are considered the drill and practice for basic facts. These games can be time consuming and may take away from time spent on problem solving. Drill and practice can and should be a home task making it a family effort, which is also part of the Everyday Math philosophy. Another point about Johnny; Just because Johnny bounces off the wall as a discipline problem does not necessarily mean Johnny can't learn to solve problems at a higher level of thinking. Perhaps Johnny is a discipline problem because he hasn't been challenged.

The philosophy of the Everyday Math program is a good one. It is the implementation of the program that needs modification. Children can and should be challenged even at a young age but in certain doses. The educational society of this country has always given students an overdose of topics and skills, which was pointed out by TIMSS (Third International Math and Science Study) of 1999. This study consisted of students in grades four, eight, and twelve from the United States along with several other countries. Students were tested in the areas of math and science. They also reviewed textbooks used in each curriculum. The overall result was students scoring average to below average particularly at the eighth grade level, hence the need for change.

The effectiveness of the Everyday Math program goes beyond the realm of academics. Part of the program depends on strong parental involvement, as should any program. Home links are provided to reinforce skills and concepts learned in school in which parents are expected to participate and help. One of the problems with this is parents are not familiar with this "new math" and therefore provide little assistance. Students are instructed to teach their parents what they have learned as reinforcement, which could be a problem if the student has not adequately learned the skill or concept. A good home task could be reinforcing basic facts by utilizing the family fact cards and possibly some of the games used in their daily routine. In some cases parents aren't available to help with homework because they are working or just aren't there, especially in the lower socio-economic communities.

Someone has apparently listened to the concerns regarding the Everyday Math program. A modified version of the program is currently being piloted in certain city schools, which focuses more on basic skills instruction. According to a May 2003 issue of the Pittsburgh Post Gazette, school officials are also suggesting math "specialists" teach the program in third through fifth grade instead of the regular classroom teacher. The specialist should have a stronger knowledge base than the regular teacher or at least have the proper training to teach the program effectively. Suggestions to teach more parallel to state and national standardized tests are also given a high priority under the revised curriculum. The Bush administration has implemented the No Child Left Behind Act of 2001. Beginning with the 2003-2004 school year, after school programs will be available to help students in reading and math skills. This program should be beneficial to those students from lower socio-economic communities and the so-called "latch-key" kids. Perhaps these changes along with the continuing emphasis on problem solving will help to narrow the achievement gap facing our local community and today's society as a whole.

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Figure 1

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Figure 2

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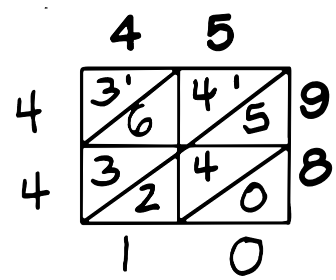

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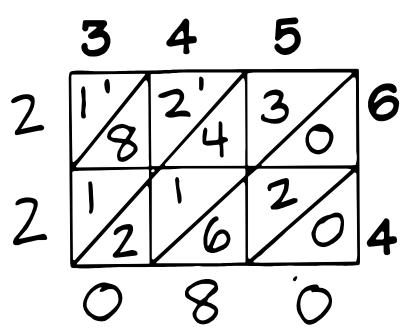

Figure 3

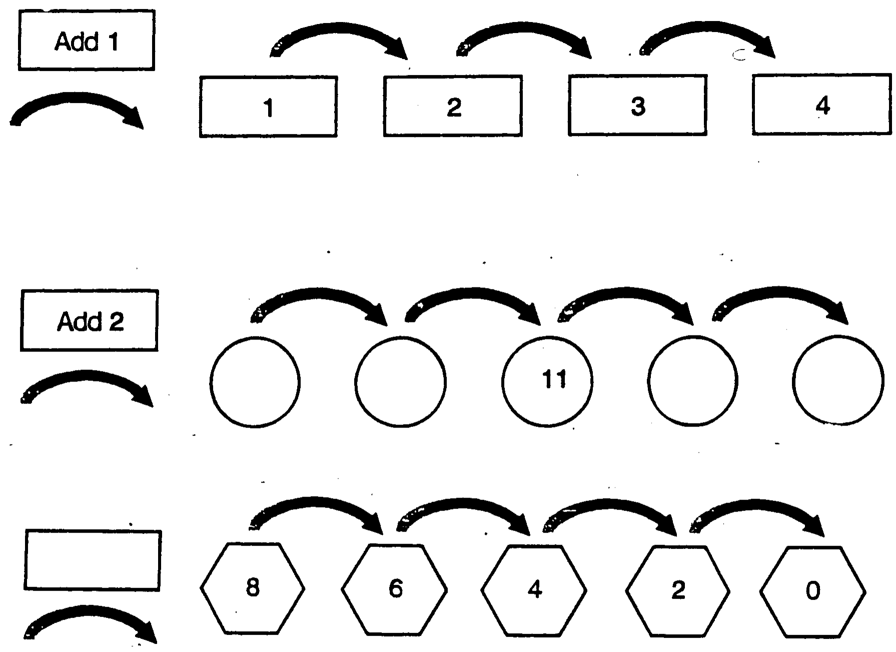

Figure 4

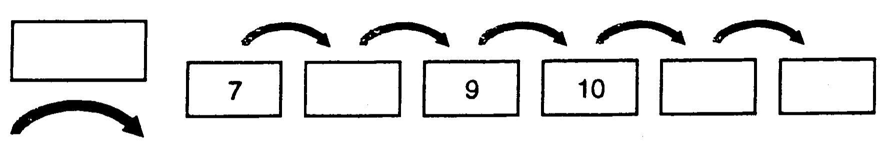

Figure 5

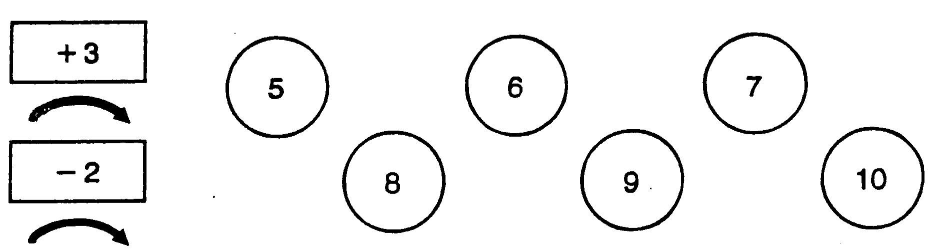

Figure 6