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ABSTRACT

Independent neighborhood schools in inner-city areas serve primarily minority students. They are in a position to assist American educators in understanding the best methods of teaching minorities who usually do not reach their full academic potential in public schools. Teachers in independent schools use culture and sometimes religion as a basis for motivational and management techniques. The students use their own indigenous images to shape their intellectual, emotional and creative development. In 1984 a training semi¬ar using this cultural model was developed to provide these teachers with a better understanding and more strategies for teaching mathematics. This first of a two-volume series contains the lectures from the seminar. It gives the cultural and philosophical foundations for teaching mathematics to black youth. Volume I includes the following presentations: (1) Cultural Foundations for Teaching Black Children (Edwin J. Nichols); (2) Innovation and Motivation for Excellence (J. Arthur Jones); (3) African Contributions to Mathematics, Science and Technology (John Henrik Clarke); and (4) Managing Instruction in Mathematics for Elementary Schools (Bessie C. Howard). The final section is a series of notes reflecting teachers' comments on how they manage their classrooms. The volume concludes with a list of mathematics and materials. (VM)

# Teaching Mathematics

## Volume I: Culture, Motivation, History and Classroom Management

Edwin J. Nichols • J. Arthur Jones
• John Henrik Clarke • Bessie C. Howard

Edited by
Oswald M. T. Ratteray





2

Institute for Independent Education

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# Preface

Three years ago, before founding the Institute for Independent Education, I was able to travel across America and visit over 40 independent neighborhood schools. I found that they were serving primarily African-American, Hispanic-American, American-Indian, and Asian-American youth. The schools were located primarily in inner-city areas, while their enrollments often included children from many socio-economic neighborhoods, and from both minority and mainstream ethnic groups.

As I talked with administrators, teachers, students, and parents, I also realized that these schools represented a very special national resource. They could show America how to assist our young people, most of whom are trapped in schooling experiences that prevent them from reaching their potential.

These administrators are building institutions that are responsive to marketplace demands for educational options. The teachers use culture, and in some cases religion, as a context that gives meaning to the acquisition of knowledge. Parents make great economic and personal sacrifices to send their children to these schools. The children achieve heart-warming results by relying on their own indigenous images to shape their intellectual, emotional, and creative development.

In 1984, the Institute asked the schools what they needed. Responding to this survey, we developed a teacher training seminar which we called "MATH Alive!" Its purpose was to provide mathematics teachers in elementary and secondary schools with a deeper understanding of principles in mathematics, their application in classrooms at different grade levels, and strategies for classroom management. This two-volume series, *Teaching Mathematics*, summarizes the lectures and the remarks of guest speakers at the seminar.

The first volume sets the stage for teaching mathematics (or indeed any other subject) to Black youth, and the principles discussed may apply to the education of other minority-group youth as well. The major presentation in this volume is by Dr. Bessie C. Howard, who lectured and conducted workshops for two weeks on classroom management. The guest speakers whose remarks pertained to this theme were Drs. Nichols, Jones, and Clarke. They bring their unique training, experience, research, and understanding to the problem of educating inner-city youth. In addition, there are strategies the teachers said they utilized in their own classrooms. The collective wisdom and vision of all these individuals can help us develop approaches that will anchor mathematics instruction in the cultural essence of the particular groups of children we must teach.

The second volume bridges the gap between theoretical or philosophical perspectives and mathematical principles. Drs. Tepper Gill and Gerald Chachere outline a two-week approach to mathematics that can serve as a model for other teacher-training courses. Their presentation is supported by presentations on classroom strategies by two guests, Sister Mu'minah Saleem and Mr. Walter Young, as well as further contributions from the teachers in training.

This publication is a part of the Institute's effort to support the development of independent neighborhood schools across the country. However, it will be useful to all teachers in American schools who are charged with the education of minority-group youth.

We at the Institute believe that education is more than just getting information. We must make information useful through relevant application, and we must build self-confidence in our children. Furthermore, we can apply to all Americans what the late Dr. Carter G. Woodson said was necessary to educate the African-American:

> "[W]e must find out exactly what his background is, what he is today, what his possibilities are, and how to begin with him where he is and make him a better individual of the kind that he is."

To meet the varied needs of our rapidly-changing society, our students should know who they are and what they have to offer America and the world.

**Joan Davis Ratteray, Ph.D.**
*President*
*Institute for Independent Education, Inc.*
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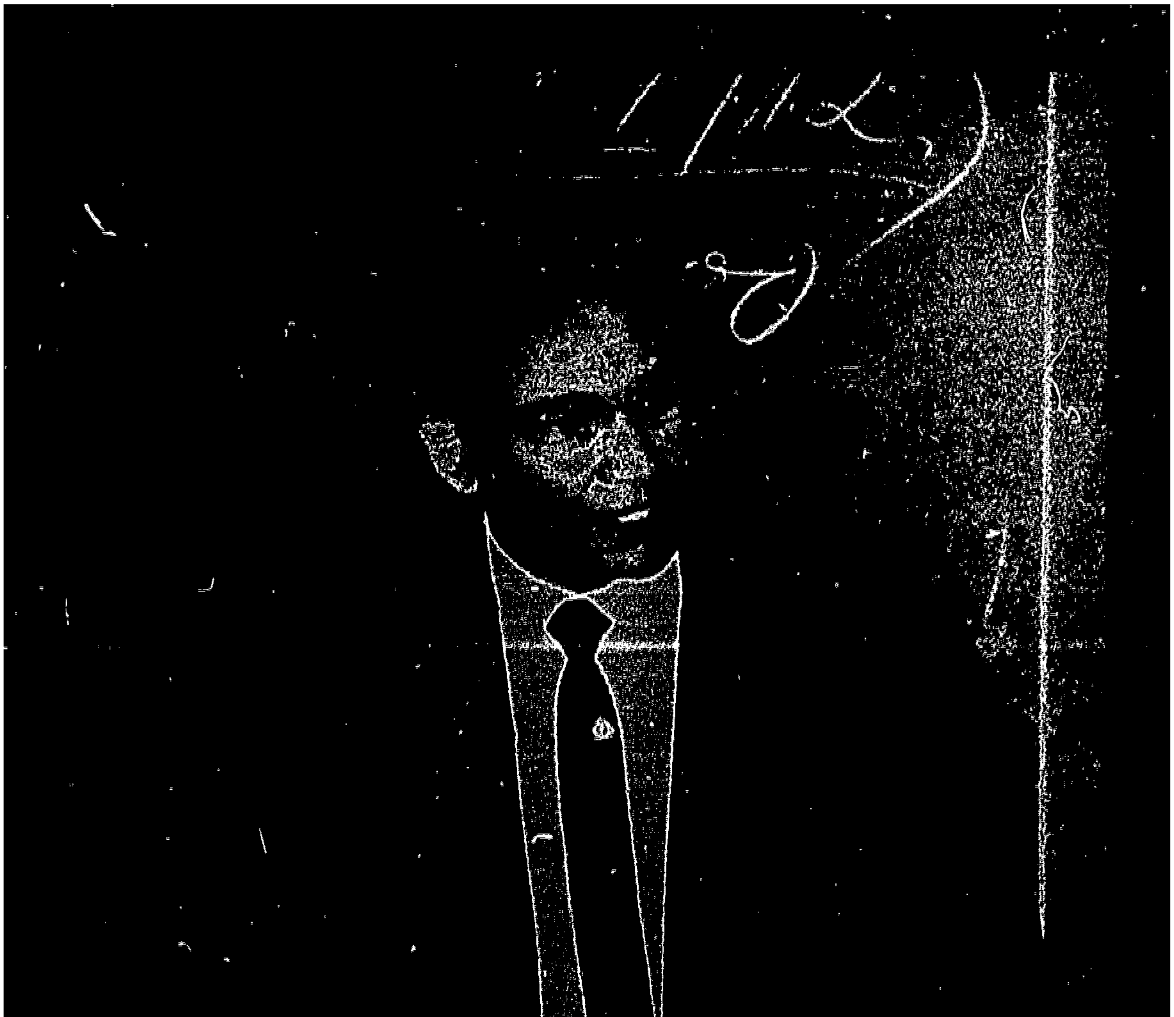
# Contents



# Cultural Foundations for Teaching Black Children

by *Edwin J. Nichols, Ph.D.*

The education of Black children in America has been very ineffective. On the one hand, there are widespread academic failures by children in inner-city schools. On the other hand, students in high-intensity academic programs at schools with predominantly White enrollment often find that neither they nor the institutions adjust to each other, with serious academic and social consequences for the child. There is also a considerable amount of stereotyping that results in fewer females having an interest in mathematics-related careers.

Damage occurs because many educators fail to recognize important cultural differences between Europeans or Euro-Americans and Africans or African-Americans. In the schooling process, children from one ethnic group are expected to use some of the problem-solving strategies of other groups. Inevitably, however, serious cross-cultural problems arise.

One way to see more clearly these differences in behaviors and thought processes is to examine their bases in philosophy. We can then begin to evolve new strategies for the successful education of African-American children, especially in inner-city schools.

There are, for example, differences in the values they hold, which we can see by studying the *axiology* of each group. Differences in how they come to know knowledge are apparent through *epistemology*, and we can understand how they reason by looking at *logic* systems. Let us examine how each of these philosophical constructs has cross-cultural implications for learning, as Black children find themselves in what are essentially European settings in American classrooms.

## Axiology

The two cultural groups, Europeans and Africans, have different axiological referents: Man-to-the-Object and Man-to-Man.[1]

1. This is part of a scheme presented at the "World Psychiatric Association and Association of Psychiatrists in Nigeria" conference at the University of Ibadan on November 10, 1976, when the author was Visiting Professor for Clincial Psychology and Director of the Child's Clinic of the Institute of Education, University of Ibadan, Nigeria.

The European focus on Man-Object dictates that the highest value lies in the Object or in the acquisition of the Object. Some of the things that could be classified as Objects would be land, work, time, and so on.

The significance of land as the Object can be seen by looking at White farmers. They are losing their land, and their loss of the Object causes them to see themselves as value-less. Because the highest value lies in the Object or the acquisition of the Object, then life itself is of a lesser value. Significant numbers of these farmers, therefore, are at risk for suicide.

Work represents another Object to illustrate this concept. When I was in school, I wanted to be an industrial psychologist. In America at the time, one could not graduate in this field without serving a practicum, and none was made available to me as a Black man. So I went to study in Germany, where I could get the required practicum.

I was then invited by a prospective employer to interview for a job in Cleveland. From our telephone conversations, he did not realize I was Black. During the subsequent interview, there were several awkward moments, but my credentials could not be denied and were above question. My interviewer then told me he was extremely sorry, he could not hire me because the secretary would quit before she would work in an office with a "Negro."

Meanwhile, I lived at the Black YMCA and worked as a short-order cook. One day, there was a huge envelope in my mail containing a stack of papers and a signed, blank check. There was also a note telling me to complete the work, fill in the check for any amount I wanted, and mail the work back to the firm where I had interviewed for employment. Their highest value was in the Object—the check and the work they wanted performed. They did not value my feelings.

The third Object we can discuss is time. In Western society, the concept of time is linear and sequential. If an employee is scheduled to be at work at A and leave work at B, but the employee does not arrive until A-prime, that person is late. The space from A to A-prime is an Object, and Objects that are lost are wasted. They must be replaced or paid for. Thus, reducing paychecks for tardiness has a basis in European axiology.

The African concept of time can be portrayed by a spiral. In Black English, there is an expression, "What goes around comes around." In other words, if a task is not begun at one loop on the spiral, it can be started when time comes around again or after skipping several times. The threat of docking pay does not have the same meaning as in the European axiology.

In African axiology, the focus is on Man-Man. Here, the highest value lies in the interpersonal relationship between persons. If Man-Object were the axiology of Black people, we would all be dead, because we have not had full employment since slavery.

The Man-Man axiology explains why the highest cause of death for Black males between the ages of 17 and 34 is to be killed by another Black man. Go to a jail and ask, "Whom did you kill and why?" You will probably be told the person killed a cousin/brother/best friend "because he called me a . . ." Whatever he called him broke the relationship, which is of the highest value, and life itself then was of secondary or lesser value.

Based on the axiology of Man-Man, a teacher of Black children must realize the importance of having a personalized relationship with each student. If the child is not made to feel important to that teacher, then there is no environment for learning.

The relationship can be established at the beginning of the class period and reaffirmed at the end. There should be at least an introduction and words of welcome, going well beyond a perfunctory, "Good morning, class." There should be words of praise for work well done. Teachers should not hesitate to comment on a student's negative or disruptive behavior, perhaps doing it with a laugh and a smile. The point is that the teacher must demonstrate with *conviction* that he or she really cares about each child.

At this point, the teacher can make the transition to the lesson plan by saying, "Now let me exlain to you what your competition knows."

## Epistemology

Africans and Europeans also know knowledge differently. Africans know through symbolic imagery and rhythm, while Europeans know through counting and measuring.

An example of symbolic imagery and rhythm can be found in the tomb of Rameses IX. There is a diagram of a pharoah, lying along the hypotenuse of a right-angled triangle that is formed by the body of a snake.[2] It establishes the direct relationship between $\pi$ and $\varphi$, in that $\pi = \varphi^2 \times 6/5$.

This is one of many mathematical formulae know by Africans and utilized architecturally for centuries before the coming of the Greeks, to whom these formulae have been incorrectly attributed.

Individual Greeks spent from 10 to 20 years in Africa, but with a life expectancy of only 30 years, they needed an efficient way to transmit to the rest of Europe the knowledge they had acquired in Africa on many subjects, including mathematics and medicine.[3]

Foremost in the development of a suitable procedure to transmit this knowledge are the ideas of Socrates and Plato. Socrates created a new approach to hypotheses and logical argument by initiating the use of critical analysis for propositions. Plato developed the concepts of form and categories which necessitated that one measure objects and then count the measured objects to know in which category they are to be placed.

In gratitude to the Greeks for their assistance in defeating the Persians, the Egyptians permitted the Greeks to establish a school at Alexandria. People

2. Peter Tompkins, *Secrets of the Great Pyramids*, p. 194. (New York: Harper Colophon Books, 1978). The visual geometric/architectural text in the tomb built by Rameses IX (1304-1237 B.C.) depicts principles that had been utilized hundreds of years earlier in the Temple of Karnak, built by Amenhotep III (1403-1365 B.C.)

3. The Egyptians' advanced understanding of medicine is demonstrated by the Edwin Smith papyrus, which is a textbook on surgery. This papyrus is believed to be a 1600 B.C. copy of a 3000 B.C. treatise. It presents the diagnosis, treatment and prognosis for clinical cases of injuries to several parts of the body, including the head. It shows the relationship of the pulse to the heart, and it describes how the stomach, bowels, and larger blood vessels function. (See the *Encyclopaedia Britannica.*)

like Euclid, Archimedes, and many others, used their understanding of the Socratic critical method and the Platonic frame of reference to transliterate African epistemology and knowledge into a new Western epistemology and "Greek" knowledge.[4] Thus, Greece became the "cradle" of Western civilization.

From the European perspective, one counts and measures by going from the parts to the whole. Information is presented with the parts numbered sequentially, as in A, B, C, followed by 1, 2, 3, then by a, b, c, and finally i, ii, iii. All of these parts become the whole. Even Head Start relies on counting and measuring, identifying colored circles and squares and placing them in their correct locations.

African-American children start with a different epistemology, from which they first see the whole. Subsequently, if necessary, they attend to the parts. Teachers in American schools, however, primarily teach from the European model of parts to the whole. The difficulty for Black students is to make the transition from one epistemological framework to another.

Black females make the transition by the end of the first grade and sometimes earlier. Black males do it later, frequently by the third grade. Unfortunately, by that time, many of these boys have become frustrated with the process of "parts to the whole," which is in conflict with their epistemological framework for conceptualization of the whole. As a result, notations are placed in their school records identifying them as "aggressive," "acting out," and "disruptive to the rest of the class." They are then stigmatized by pathological labels like "slow," "learning disabled," or "retarded."

It is important that teachers of mathematics and other subjects permit Black children to draw upon the epistemological framework they intuitively use—symbolic imagery and rhythm—the approach that enables them to see whole concepts. They should not be required to begin by isolating and structuring the parts, as is the European tradition. When these children see the whole, that experience then should be validated by the teacher. As Black children learn to use that methodology, they can later make the necessary transition and experience the least amount of psychological damage.

By looking at how axiology and epistemology work together, we can conclude that Black children probably learn best when they are paired off rather than isolated. In Africa, children utilize so-called "peer learning" all the time. The noise level for classrooms is much higher than in predominantly European classrooms, although it is not disturbing noise. This is because the children are talking to each other (Man-Man) about what they are learning. In inner-city classrooms in America, when the children are absolutely silent, it may be that they are not learning anything. By placing them in small groups, such as at learning stations in open classrooms, learning increases.

Some Black teachers, trained in the European way of knowing, have difficulty understanding their own African epistemology. While Black teachers

4. The Rosetta Stone is evidence that the Greeks were able to transliterate hieroglyphics into their own language.

may count and measure according to the European rules, they often approach problem-solving from their own referent.

## Logic

The European logic system has its basis in dichotomy, by which reality is expressed as either/or. African logic, however, is diunital, characterized by the union of opposites.

In the Bible, the Pharisees confronted Christ with a tricky question: Do you pay taxes to Caesar? They expected a yes or no answer. If he had said yes, the religious community would have called him a hypocrite. If he had said no, the Romans would have jailed him for tax evasion. So he took a coin and asked whose picture was on it. Then he said give to Caesar that which is Caesar's and to God that which is God's. Christ used a diunital answer to avoid the pitfall of a dichotomous question.

When children give us answers like this, we call them "smarty pants." Instead of telling children not to do this, we should say to ourselves, "My goodness, that's an interesting diunital response."

Another important outcome of dichotomous thinking can be seen in the following group of words:

| | |
|---|---|
| assertive | submissive |
| aggressive | passive |
| powerful | powerless |
| strong | weak |
| intelligent | ignorant |
| independent | dependent |

These are only lists of characteristics, grouped as polar opposites. Nothing happens until we superimpose unconscious cultural bias. For example, if maleness in our society is superimposed on the positive side, males then are socialized to think of themselves as assertive, aggressive, powerful, strong, intelligent, and independent. If femaleness is superimposed on the negative side, women are then trained to be submissive, passive, powerless, weak, "ignorant", and dependent.

People often find themselves locked into one paradigm or the other, unable to move. For example, when a White woman tries to cross the line of dichotomy and move up in a firm dominated by White males, she is called "pushy and hostile," labels that begin to identify her behavior as aberrant or sick.

Minorities are also locked in. When a Black male, surrounded by predominantly White males, attempts to follow the assertive-independent paradigm, he is perceived as dangerous. To neutralize the danger, he is often physically or psychologically forced into the negative side of the dichotomy.

This explains why, until the Bill Cosby show started this year, television showed no positive role models for Black families. Black males were not allowed to work successfully and be fathers to their own children; Black children were being raised by White fathers.

Adult Black males, forced to vacillate between being assertive at home and submissive in public, internalize so much anger that hypertension has become one of the highest causes of death among Black men.

When positive/aggressive Black women attempt to switch paradigms, they are called by the derogatory name of "Sapphire." Their suppressed anger tends to manifest itself before the age of 45, frequently requiring a hysterectomy.

There is another group of words that is also treated similarly. Consider the following:

| | |
|---|---|
| wealth | poverty |
| industry | laziness |
| thrift | wastefulness |
| punctuality | tardiness |
| cleanliness | dirtiness |
| beauty | ugliness |
| farm subsidies | welfare & AFDC |

The left column is frequently used to describe White males and their activities, while the right column often refers to Black females. To sustain this dichotomous logic, White males suffer high rates for suicide and alcohol consumption. White women are bounced like ping pong balls between the good (White) and the bad (female) side of the paradigm. Consequently, they have the highest depression rate and the second highest suicide rate. That is the price they pay.

Child-rearing practices also illustrate dichotomous logic. In the European context, children are not physically held for long periods. They are left in playpens to be independent. They grow up to reflect the characteristics in the assertive/aggressive paradigm. This, of course, is important if the highest value lies in the Object or the acquisition of the Object. In traditional Africa, children are carried on the backs of relatives for long periods of time. In African-American communities, they are also physically held by the mother or given to someone else in the extended family to hold.

Dichotomous logic has applications in many fields, such as computer programming, but problems arise in utilizing it to describe human characteristics and potential. When the characteristics of individuals are allocated to polarized groups, they can be ranked as either "good" or "bad." While this practice is not inherently dangerous, it is dangerous to superimpose these polarized characteristics on specific groups of people. Thus, in a male/female context, men are good and women are bad. In a White/Black context, Whites are good and Blacks are bad.

It is the responsibility and obligation of educators to avoid the pitfalls of stereotyping and labeling. In the mathematics classroom, or in conversations on math-related subjects, it can certainly lead to the development of math phobias among girls. Teachers should be mindful that the tendency to dichotomize may appear when they are teaching, when they are reading from textbooks, or when they are listening to their students develop arguments.

Black teachers have a special need to develop curriculum materials and utilize manipulatives that will enable Black children to focus on African axiology/epistemology/logic sets. However, it is critical that all teachers not be restricted to only one way of viewing the world, for if only European axiology/epistemology/logic sets are practiced, then only selected individuals will benefit.

The challenge in mathematics classrooms and in education in general is to develop a process by which significantly larger numbers of Black youth can be brought into the mainstream of learning. Understanding the cultural foundations for teaching Black children will help accomplish this objective.

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# Innovation and Motivation for Excellence in Mathematics Education

*by J. Arthur Jones, Ph.D.*

Mathematics abounds everywhere. It is the most natural process in the world. In fact, I always say that God is a great mathematician. My concern is that in teaching children, we often present mathematics in a very unnatural way. The result is that we take away a child's motivation. Children do not learn as much mathematics as they can, nor as quickly as they can, because we are not innovative in our approach. We also do not accommodate the various learning styles of students.

One of the most natural processes is counting. Most people will say that a two-year-old cannot count. But if you were to ask a two-year-old to go into a room and see if there are enough chairs for the people gathered in the room, the child will probably tell you yes or no. The child will make a one-to-one comparison of two groups or sets: people and chairs.

Counting and measuring are both forms of making comparisons. People compare big things with little things, short with tall, one color with another, the length of objects with rules, and so on. They do not question the process; it is natural. Another natural process is dealing with abstractions. Children who are told that one object is called a "car" will also determine that another object in this same class is also a car, even though it may have a different size, shape, or color. The child has instantly identified the essential parts, discarded those which are not essential, and made the correct association. We are always abstracting.

With motivation, there is observation, which in turn leads to the application of a principle. This then generates more observations, and the process continues. We sometimes find that the conclusions we draw from our observations are not correct, and the process is repeated. Thus, we develop intuitive knowledge about our environment and the principles on which it operates.

If we are born motivated to count, if we make observations from the real world and make comparisons or measurements, and if we naturally abstract, what changes us? What turns us off? Why do some children begin to say, "I hate math"? What happens is that we do not incorporate natural experiences from the lives of children in order to motivate them.

Counting itself is a natural process, and unlike the Romans, we use convenient symbols to represent numbers. The base 10 system of numeration is also natural, because it coincides with our 10 fingers, yet we tell children not to count with their fingers.

Many of us have great difficulty multiplying 123 by 576 or adding ⅓ and ½ At the heart of the problem is the way we teach algorithms, which are procedures for carrying out calculations in order to arrive at the desired result.

Some people associate the ability to do algorithms with the ability to do mathematics. That is not necessarily so. A child who fails to execute an algorithm still may be capable of very abstract mathematics. In fact, some of the best mathematicians in the country have difficulty performing algorithms in arithmetic. We should not jump to conclusions because a child does not do algorithms willingly or correctly.

There is a very complicated process for adding ½ and ⅓, which is cluttered with a number of steps, such as finding the least common denominator and then reducing the answer. A simpler approach is to have the child multiply the two number below the line, then place above the line the sum of the products formed by diagonally multiplying the top number in one fraction with the bottom number in the other fraction.

Another barrier to learning is the way geometry is taught. Teachers often do not realize that geometry is one of the most beautiful subjects in mathematics, because it involves objects we can see and procedures we can experience. There is no need to save geometry for the tenth grade. Instead, we should talk about it from the first day.

Consider the example of a sphere. If you hand a child a sphere made out of clay and say, "Turn it into a cube," would the child consider that a great problem? No. A ball could be turned quickly into a cube, without tearing anything or doing anything fancy, and then molded back again into a ball. On the other hand, a ball cannot be molded into a donut without tearing it apart, and the child can identify the essential differences in the two objects.

Three years ago, I was challenged to find a way to reduce some of these barriers to learning mathematics. I was asked to work during the summer with a basketball team of boys and girls who were adamant about not having anything to do with mathematics. My approach was to use the game of basketball to motivate their understanding of mathematics.

I explained the layout of the basketball court in terms of rectangles, semicircles and circles painted on the ground. We looked at the angles formed by the backboards and certain shots—for example, layups. We talked about the parabolic trajectory necessary for putting the ball through the net. By studying the different heights each player must jump in order to create different types of arcs, we learned how very short basketball players can compete against very tall players and be successful at dunking the ball. Everybody knew his or her dunking height. We covered the geometry and physics of dribbling, what changes occur when dribbling is faster and slower, and how a short person can dribble successfully in competition with a tall person.

Finally, each player kept a personal notebook with detailed statistics on his or her performance and capabilities. They each used this information not only to understand their own strengths and limitations but also to collect the same information on other players. They knew which player was the better free-throw shooter, which was the better foul shooter, and so on.

From their statistical knowledge of the entire team, they understood concepts of probability by predicting the likely performance of a given player at a particular time. From this information, they could become involved in strategic decisionmaking, such as playmaking and screening candidates for teams. In addition, we showed them how a computer can be programmed to make some of these projections, and young boys from 11 to 13 years of age were able to do this.

Ordinary basketball terms became terms in mathematics. Young people who previously appeared to have irrational fears of doing arithmetic, algebra, geometry, and trigonometry began to love those subjects. People who previously could not multiply 36 times 45 and who had been labeled "failures" turned out to be at the top of the class.

Our approach was successful because we considered the learning styles of this group of young people. We focused on what was naturally of interest to them. So often in American classrooms, the teacher is standing in front of the blackboard, lecturing to students who are only partially listening and who only sometimes offer answers to questions.

Real learning, however, occurs when students are involved and actively participating in the learning process. I and my colleagues regularly teach Saturday classes to young people. We get them involved in a subject that interests them, and we give them individualized attention rather than lectures. We find that this approach works.

For example, one student had finished seventh grade, but he always got the wrong answer when he multiplied numbers. For seven years, the teachers had simple given him an "X" for his wrong answer. We sat with him, looked at his algorithm, and pointed out the correct way to multiply. Since then, he has not missed a single multiplication problem in school. We also work closely with students on test-taking skills, and one young man at age 11 made 780 on the math part of the SAT because of our approach to enhancing his natural ability.

I contend that if young people can learn fancy dunk shots and develop complex football plays, doing all of the computations in their head, but cannot add one-half and one-third, something is wrong with the processes used by their teachers. We fail to provide enough teachers in our schools, yet we spend $50,000 to build a prison cell and $30,000 every year to feed and care for a single prisoner. Many of them, too often, cannot read and write.

The students in our elementary classrooms today will live more than half their lives in the twenty-first century where computers will have a significant role in the lives of everyone. Although computers are now in a primitive stage of development, by the twenty-first century, they will be affordable by almost everyone. We must begin preparing young people for this experience.

It is important that you, as a teacher, love mathematics and love the children with whom you are working. I urge you to do everything within your power to involve your students in learning. Find out what interests them and how they go through the process of abstracting. Recognize that motivation is extremely important to learning.

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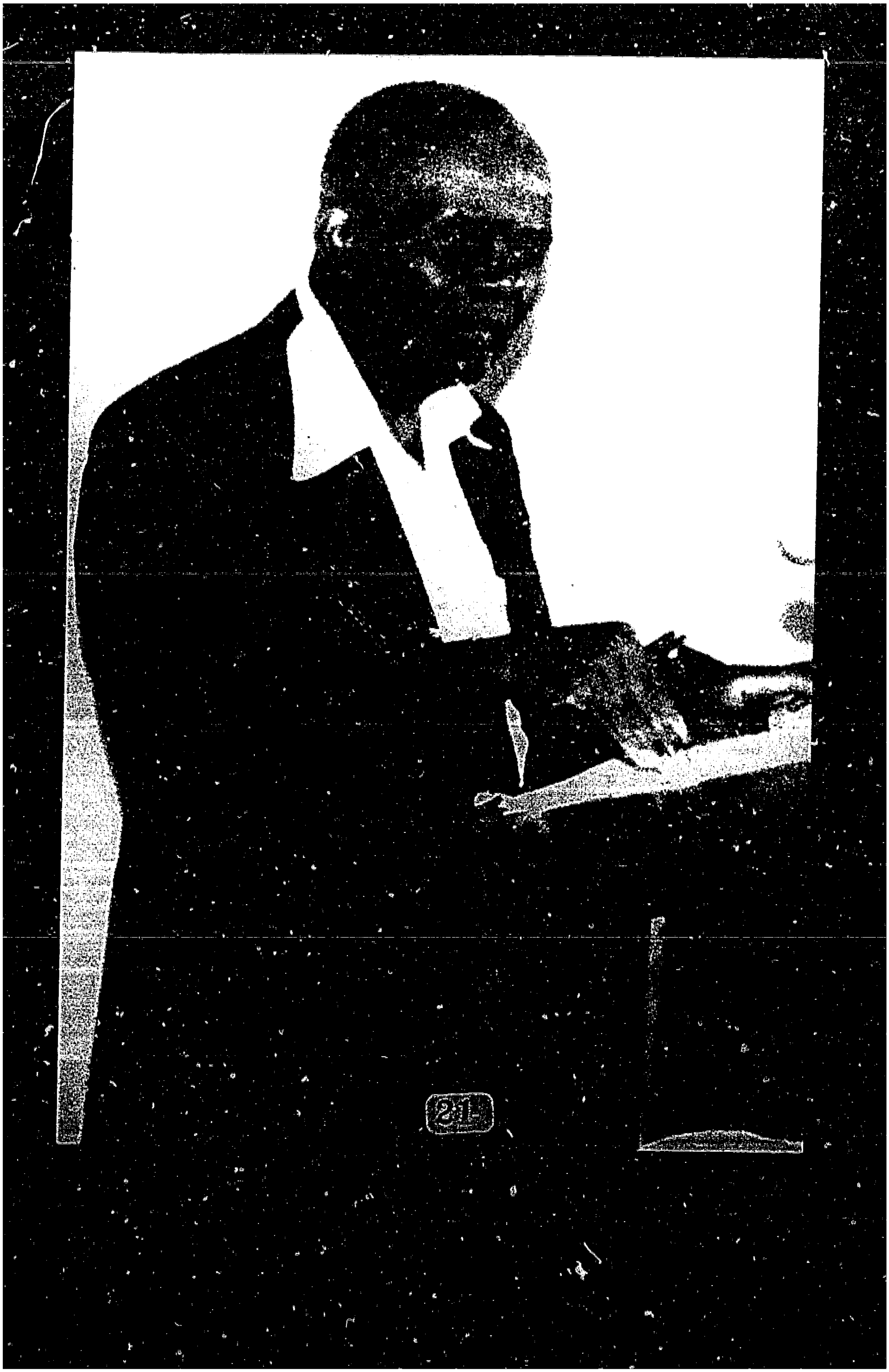

# African Contributions to Mathematics, Science, and Technology

*by Dr. John Henrik Clarke*

African contributions to mathematics, science, and technology have shaped the present, the past and the future. They represent Africa's gift to humanity, which is not only incontrovertible but is continually being reinforced.

The people called Africans are the oldest of the world's people[1], as African civilization existed for nearly 5,000 years before the first city-state was created in Europe. However, beginning in the 15th century, Europeans began to obscure the light that had stretched from the Nile Valley to southern Africa.

After the Middle Ages and the Crusades, Europeans began to regain, mostly from China, some of the maritime skills they had lost, such as an understanding of latitude and longitude. They searched for the spices and the sweets of Asia to make their food palatable. They recovered from famines and plagues that had claimed one-third of their population. To rebuild their society, they enslaved many people, including other Europeans. They made the world their servants' quarters until the eve of the twentieth century, and most of it remained under their control for at least another fifty years.

The history of Africa and African people was locked into what Professor Van Sertima called the "500-year room," implying that African history was stopped and that nothing happened.[2] Because Europeans dominated the textbooks, the mass media, and the Bible itself, the world believed—and to some extent still believes—what they said. They said that the people who came out of Europe brought enlightenment to the world and that all the world waited in darkness for Europeans to bring the light.

Their first self-deception was soon followed by another. They said that a country called Egypt laid the foundation for Western civilization. Egypt was

1. Yosef ben-Jochannan, *Black Man of the Nile and His Family* (New York: Alkebu-lan Books, 1972). See also: Ivan Van Sertima (ed.), *Blacks in Science: Ancient and Modern* (New Jersey: Transaction Books, 1983) and R.R. Palmer and Joel Colton, *A History of the Modern World*, 5th ed., p. 3 (New York: Alfred A. Knopf Co.).

2. From a speech delivered by Ivan Van Sertima on February 19, 1978, at the Mt. Zion Lutheran Church, New York City, in a lecture series sponsored by the First World Alliance.

not then and never was a part of Western civilization. Europeans rested the foundation of their civilization on a concept that was basically false. Even today, elementary and high school mathematics texts omit the first 3,000 years of written mathematics history.[3]

I maintain that in withholding from the world information about Africa, Europeans have deprived themselves and their children of knowledge they need in the immediate tommorrow, for we are facing a time when a new humanity needs to be established for all people.

Let us begin by putting Egypt back into Africa. Let us deal with the African origins of Egypt and the role of technology, mathematics, and science in Egypt. For to leave Egypt out of Africa is like having an equation which says that two and two make three; everything from that point on is out of order.

When the intellectual miracle of Egypt existed, it was physically within the body of Africa. The Nile Valley stretched 4,000 miles into the continent, and the technical achievement of Egypt was an achievement of the totality of Africa and not merely of one part of Africa.

Let's go to the Sahara before it became a desert, when it was green and when there were cities in that area. When the Sahara dried up, the Nile Valley inherited a great deal of talent seeking a new home. Some of the people gravitated toward the Niger, where they built a great civilization on the Niger River, while others drifted as far down as the Congo River.

In an ancient Egyptian text, the Papyrus of Hunefr, it is written: "We came from the mountain of the moon, where the Great God Happi dwells." The "Great God Happi" is an early god of the Eyptians. The "mountain of the moon" means Kilimanjaro. That means, they originally came from the area we know as Kenya and Tanzania. They did not come from Western Asia. They did not come from Europe, because it did not exist at that time.

Mathematics, science, and technology were integral parts of life in the Nile Valley. There was no "Egypt" in existence, because "Egypt" is not an African word. The people of that part of Africa called their country Ta-Merry, and some called it Meroe. The ancient Hebrews, who came late, called it Mizrain and Kampt. The Greeks later called it "Aegypitus," out of which came the word "Egypt."

Some have claimed that mathematics, science, and technology came from western Asia, but over 1,000 years were to pass before there was a meeting of people from the Tigris, the Euphrates, and the Nile valleys. Nor did the technology of China and India predate Africa's systematic development of mathematics, science, and technology, for Africa's was the first great showing of technology known in human history. There is evidence that 43,000 years ago, the people of Swaziland, southern Africa, learned the technology for separating iron ore into seven different categories. Ironically, these findings were documented mostly by European archaeologists and paleontologists—evidence from the people who said the evidence wasn't there.

3. Beatrice Lumpkin, *African and African-American Contributions to Mathematics*, Pre-Publication copy, prepared for the Multnomah School District 1J, Portland, Oregon, 1985. See also: Early Grant, "African Women: Mathematics and Astronomy," Supplement to *National Scene Magazine* (New York), June 1984.

We are forced to conclude that there is no way these ancient achievements could have been made without someone knowing something about math, geometry, and basic science.

However, let us begin where the evidence is clearer. Let us look at the Third Dynasty (2778-2723 B.C.), the builders' period and the genius of the great Imhotep.

We begin with Imhotep because we can prove that he was a scientist, an architect, and had a philosophical approach to science. He was the Grand Vizier, or advisor, to King Zoser. Builder of the step pyramid, one of the first stone structures known to man, he knew the science of building.

He was also the world's first physician. Hippocrates, the Greek who is incorrectly called the father of medicine, said, "I am a child of Imhotep." In other words, he was inspired by the African, Imhotep, who lived 2,000 years previously. Imhotep performed one of the world's first recorded operations, so by any definition, he was a scientist.

As a philosopher, Imhotep laid the basis for the "mystery school" and what became the Grand Lodge at Luxor. Through him also, intellectual life of that period took a great leap forward, because it was from the Third Dynasty through the Sixth Dynasty (2778-2270 B.C.) when most of the pyramids and sphinxes were built.

The intellectual history of Africa can be traced to the first book known to come out of the Nile Valley, *The Coming Forth of the Day and the Night,* called "The Book of the Dead." This book was about 3,000 years before Europe's first book, the *Odyssey* and the *Iliad,* which may have been written as early as 1200 B.C. Looking at the history, achievements, and age of both people, as well as the age of other parts of Africa, it leaves no room for argument about the intellectual development of one over the other.

African contributions to mathematics, science and technology have been so belittled by European historians that many texts attribute achievements to the various visitors and invaders of Africa. However, it cannot be claimed that invaders and visitors to Africa built anything of consequence. The visitors did not begin to come in until the Thirteenth Dynastic period (1785-1680 B.C.), and the invaders came near the end of that period. Major building had come to an end by that time.

With the first invaders, a people called the Hyksos or "shepherd kings," many people left Egypt. Most of those who left were talented people who had built the river civilization of Africa. As Egypt's great talent was driven away, some of the Nile Valley people settled among other river people in the Congo, the Limpopo, the Zambezi, and the Benou valleys.

After the first invasion was expelled from Egypt, 1,000 years passed before the second invaders came. There was a wave from Assyria, now called Syria and another from Iran. Then came the Europeans for the first time, following the young Alexander. After that came the Arabs.

All of Africa's invaders did more harm than good, tearing down more than they gave. Contrary to the textbooks, the first European invaders, the Greeks, destroyed. The Romans destroyed Carthage and never built is back. Now Africa is laid prone. After the Romans stopped killing Christians and became

Christians themselves, Roman mismanagement brought on Islam.

The Arabs brought order and education, copying a great deal of the ancient science and technology and improving upon it to create an important age of Islamic science,[4] but they also destroyed. The Arabs, with the help of Africans, controlled Spain and the Mediterranean from 711 to 1492, but the Arabs then started an African slave trade 600 years before the European slave trade.

The great University of Sankore at Timbuktu was the largest university of scientific and medical training in Africa.[5] The cry of the Black Islamic scholars there was, "Believe in science and God." But the Arabs from the north destroyed both the University of Sankore, the last center of learning, and the effective organization of inner Africa. This occurred at the same time the slave trade was starting along the coast.

As the slave trade moved inland, it destroyed African trading posts, basic African coastal technology, and African iron workers. Europeans then took the best of African craftsmen out of Africa, bringing many of them to the New World. These were not illiterate slaves but people who knew basic carpentry and ironworking.

We should note, however, that the first slaves brought to the New World were not from Africa at all. Once Europe gained control over the Mediterranean, where the Africans and the Arabs were partly in control, Europeans began to enslave the Africans there. This accounts for the large number of African technicians with the Spanish conquistadors; the African pilot, Alonzo Nino, who came with Christopher Columbus; and the African wheat farmer with Cortez. There were African technical workers with Balboa, who built the road across the Isthmus of Darien, now the Isthmus of Panama; they were people who could plan, design, and supervise the building of roads, not mere laborers.

As a result of the slave trade, Africa lost not just bodies but skills. Many of the craftsmen who designed the iron work at New Orleans were African iron workers, and some of that work still can be seen. Africans also built some of the beautiful mansions in the South, where a great deal of the design was distinctly African.

In the West Indies, the British brought Englishmen to fix the sugar mills, to make furniture and to do basic things. These lower-middle-class workers, who had no particular status in England, now had status with the color of their skin and a gun. They were replaced by African craftsmen: blacksmiths who could fix the sugar mills became the wheelmasters and worked their way out of slavery ahead of the others. This is the origin of the Caribbean free

4. Rom Landau, *Arab Heritage of Western Civilization* (New York: Arab Information Center). See also "Science: The Islamic Legacy," *Aramco World Magazine*, Vol. 33, No. 3, May-June 1982.

5. Eleanor Hoffman, *Realm of the Evening Star: Morocco and the Land of the Moors* (New York: Chilton Press, 1965). See also: John Jackson, "Africa and the Civilizing of Europe," Chapter IV, *Introduction of African Civilization* (Secaucus: Citadel Press) and Felix DuBois, *Timbuctu the Mysterious*, translated by Diana White (New York: Negro Universities Press, 1986).

man, many of whom made the cutlass and the stabbing weapons that went into the Caribbean slave revolts.

In the United States, the New England winters were so long it did not pay to maintain a slave all year to work for only six months. So the slave in New England became an industrial slave, a carpenter to be hired out. In this age of sailing, wooden ships were caulked every time they came in to keep them from leaking at sea. Ship caulking was a big industry, and Blacks could do that well. Owners collected the slave's salary but gave the slave a portion. The slave eventually had enough money to buy his freedom. This is the origin of the Black free man in New England.

He was not "free" in a general sense: he could not vote, and he was limited in his travel, but he soon began to be an independent entity as a free man. Then there was communication between the two free men. The intellectual class and the craft class in the West Indies met the craft class in the United States. The meeting of these two groups occurred before emancipation in the West Indies and before emancipation in the United States, creating a Black abolitionist movement before the White abolitionist movement began.

This new group of Africans was the forerunner of Black intellectuals who would later be called the "Black middle class." It was a social class that existed before the mulattos. It consisted of people who earned their position and who worked their way to semi-freedom by being good craftsmen and who, dollar by dollar, bought their freedom. In looking at mathematics, science, and technology, we must acknowledge that the mind of Africans, both at home in Africa and in the New World in the first half-century after Emancipation, mastered these subjects and built institutions.

When our children come home and say that math is "hard" and that science is "difficult," we need to have them look at the totality of their history. Tell them:

"I imagine that building the pyramids must have been a little difficult, too. I imagine, putting all that stone on top of stone, without any cranes and pulleys, must have been kind of difficult. I imagine in an area of the world that had no stone quarry, stone was brought from thousands of miles down that river. Even building the barge that would hold it up without sinking must have been difficult.

"If they did it at a time when they had no modern equipment and no electricity, I don't want to hear any nonsense from you about math being hard. It was very hard for them, and they got it up there. They did it, and nobody did it for them."

We have to look at ourselves in the world, our responsibility in the world, and our mission in the world. By the 21st century, there will probably be a billion Africans on the face of the earth, while Africa is a continent of nearly 12 million square miles with many resources to manage. Yet, the richest continent in the world is full of poor people.

Mathematics, science, and technology will be required to unlock the body of that continent and make it deliver more for the proper feeding of its people. Most people will agree, for example, that famine is unnecessary on that continent. I, too, have sailed down its big rivers, especially the Congo, which at some points is three miles wide. It is obvious that good engineering could have stopped famine in Africa years ago.

Nobody is going to change the draining of Africa but African people themselves. African people are in the enviable position of not needing to conquer anybody, but they have to reconquer their territory and themselves. They are able to feed, house, clothe, and educate themselves. Indeed, the technical knowledge needed by the people on that continent might rest with those millions of Africans who live outside Africa. The key to achieving this is in the restoration of self-confidence.

Out of the valleys of the Nile, the Congo, the Niger, the Limpopo, and the Zambezi came civilization long before Europe's and Asia's. There was a human way of life that the world has chosen to forget. Sometimes the world has claimed for other people that which was distinctly African.[6]

We must reclaim our past and reclaim our confidence and we can do it without encroaching upon anything in the world that rightfully belongs to other people. We might be a people who can give the world a promise of peace and keep it. We should say, "If we did it once, we can do it again."

6. George G.M. James, *Stolen Legacy* (San Francisco: Julian Richardson Co., 1976).

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His special area of study has been the history of African people around the world.

# Managing Instruction in Mathematics for Elementary Schools

*by Bessie C. Howard, Ph.D.*

Effective mathematics instruction is not merely something that is "given"; it must be "managed." It is a broad-ranging effort by a teacher, involving the environment and the curriculum, that makes it possible for students to learn. But it is also based on a set of management principles that respond to each student's background, learning style, and motivation.

The result is a classroom where learning can occur and where each student is encouraged to build a positive self-image and develop worthwhile human relationships. It reflects the teacher's high expectations for the student, as well as sensitivity to the combination of affective and cognitive factors which determine whether students maintain an interest in mathematics and participate in mathematics-related activities and careers in the future.[1]

## Classroom Management

What is to be managed? Certainly, there is time—for the teacher and the student. Decisions must be made about how the day is to be structured. "Time on task" is another important concept for the effectively managed classroom. The physical space of the classroom also must be managed so that it is well utilized. Instructional materials that are appropriate and useful in helping students meet their objectives need to be selected and managed. In addition, management involves the consideration of auxiliary personnel and helpers, such as parents, whether or not they are in the building. Student behavior and attendance are factors, too, as well as the relationships between students, between students and teachers, and among the teachers themselves.

Norms and standards are important, too. Standards are rules that are announced orally and sometimes posted on bulletin boards. Norms are those unwritten codes of behavior that emerge over time and eventually affect classroom activities.

Finally, there is the psychological environment, the one area for which teachers are directly responsible. It may, for example, be "loving and caring,"

1. DeAnna Beane, *Mathematics and Science: Critical Filters for the Future* (Washington, D.C.: The Mid-Atlantic Center for Race Equity, The American University, 1985)

harshly authoritarian, or somewhere in between. It may even be characterized by inconsistency. The teacher may describe it as "loving and caring" but, in order to satisfy a need to feel in control, the teacher may demonstrate behavior that is emotionally crushing to the child. In this instance, the lesson learned by the child is the opposite of what the teacher verbally claims or intends.

To give another example, some teachers have been known to attempt the "win and run" approach, making harsh or sarcastic comments to children in front of their peers in order to modify the child's behavior. However, this is really no victory at all, for it can have a lasting impact, negatively shaping the child's self-image, relationships with others in the class, and attitude toward learning.

In order to be effective classroom managers, teachers must become sensitive to a number of elements. First, the teacher needs to be aware of the difference between "management" and "control." Children will sometimes misbehave when the teacher leaves the room or is absent from school; this is normal. But if order breaks down *every* time the teacher is not present, the teacher may be exercising control but not have effective management. In this instance, a sensitive teacher would do well to ask himself or herself, "What is my influence?"

Second, the teacher should not relate to the student as a "hostage" but as a "client" with the right to be provided with opportunities to learn. If a teacher does not focus on meeting the "client's" needs, the parents may take the child to another institution. On the other hand, the child may stay and be disruptive as a form of protest, presenting another management problem that takes time away from teaching. Even worse than these alternatives, the child may silently accept not having his or her needs met and become an academic and personal failure.

Third, it is important that teachers understand the many ways in which people are unique and become aware of the dangers of stereotyping individuals. Stereotyping students often leads to a very low teacher expectations, which, in turn, become self-fulfilling prophecies.

Other factors to be considered include having knowledge of a variety of strategies for teaching and learning, such as cooperative learning, mastery learning, learning centers, and so on; math anxiety among students and teachers; flexibility in matching teaching style with student learning style; developing a positive rather than a repressive emotional climate for learning; identifying and selecting the best curriculum content and sequence; planning for effective instruction; and the importance of self-critique and peer-critique for professional improvement.

Becoming responsive to what students need starts with teachers becoming more self-aware. By analyzing their own behavior, teachers can gain a better idea of their impact on the children in the classroom, as well as on parents, other teachers, and school administrators. With this understanding, teachers can then begin to develop strategies for constructive change and an atmosphere that is conducive to increased learning.

## Who is That Child?

The teacher's function in the classroom is to help children learn. The goal is more easily attainable if teachers understand how personality types, levels of intellectual development, external and internal stimuli, and learning styles determine what children learn and how quickly they learn it.

One way to begin understanding how students learn is by looking at personality styles. There are sixteen "personality types" or characteristics which contribute to an individual's temperament.[2] People can be considered primarily extroverted or introverted, sensing or intuitive, thinking or feeling, and judging or perceiving.

Each personality type is a combination of one preference from each of these four pairs. For example, a person may be primarily introverted, intuitive, thinking, and perceiving. These four preferences together are classified as an "INTP type," and this person has a unique orientation to the world of learning.

However, these are not absolutes. Individuals utilize some of both elements in each pair, and the total set of characteristics actually reflects only an individual's *preferred* style of reacting to the environment. Adults often are able to select different operating styles, despite their preferences, as circumstances require. While children may be less flexible, they nevertheless can be distinguished by their unique sets of characteristics, which also influence their preferences for learning.

For example, does the child approach an unfamiliar visitor, teacher, or game hesitantly rather than quickly? Does a child prefer to daydream and enjoy fantastic stories, rather than prefer physical activity or factual stories? Does a child ask for reasons why, or does he try to please the teacher? Is a child always expecting roles to be settled and activities chosen by someone else, or does she enjoy being surprised and having choices most of the time?

This is not to argue that there is a "right" or "wrong" way to be. It is a matter of preference, and it affects the way children learn. These preferences also affect the way teachers teach. Hence, teachers may be prone to favor and teach to students with learning styles similar to their own, but a sensitive teacher will attempt to be flexible in choosing a teaching style and in reacting to the styles of others.

Observant teachers may have more productive classrooms with a higher quality of outcomes if different preference types are mixed together when problem-solving groups are formed. However, merely bringing opposites together can create dissonance, unless the students are made aware of their differences and experience the positive effect they can have on each other by using different approaches and perspectives.

In addition to personality preferences, we can understand how our students learn based on the various phases in their intellectual development. Four

2. D. Keirsey and M. Bates, *Please Understand Me: Character and Temperament Types* (Delmar, California: Prometheus Nemesis Books, 1978)

stages were described by Piaget.[3] They are *sensorimotor* (up to 1-1/2 years of age), where the emphasis is on preverbal and presymbolic behavior; *preoperational* (1-1/2 to 7 years), the beginnings of symbolism and logical thought; *concrete operational* (between 7 and 12 years), with the further development of logical thought and mathematical processes; and *formal operations* (over 12 years), as seen by the development of reasoning in hypotheses and problem-solving. It is important for the elementary school child, who is usually in the concrete and operational phase, to have manipulatives and concrete materials in their learning experiences.

Stimuli for learning can be found in the child's environment or they may be based internally, as in affective or physical needs. For instance, children vary in the amount of sound or light that is optimum for their learning, or they may react differently to temperature or room design and colors. They may learn better in groups of peers, in pairs, alone, or with an adult. Their learning may also be affected by their reactions to audio/visual images, food intake, the time of day, or their level of physical mobility. On the other hand, the stimuli may be internal, where each child will have different levels of persistence, motivation, responsibility, and tolerance for rules or structure.[4]

Finally, research has shown that children's learning styles may be either field-sensitive or field independent.[5] Field-sensitive children tend to perceive globally and make broad distinctions, be socially oriented to the world, attend to material they find relevant, seek goals and reinforcement and organization defined by others, are sensitive to criticism, and attain concepts as if they are "spectators."

Field independent children, however, usually perceive analytically, make fine distinctions between concepts, learn about the world in an impersonal manner, find interest in new concepts regardless of relevance to their personal lives, define their own goals and reinforcements and organizational structures, are less affected by criticism than others, and attain concepts by testing hypotheses.

The many variables defining learning styles of children can be overwhelming to consider when trying to provide effective instruction. Yet, each child deserves to be considered in as many ways as possible if learning is valued.

Teachers can do a great deal to help children with one learning style acquire or adapt the techniques of another style when that child's style appears in some way to be dysfunctional. This may be especially true for those students who attribute their successes or failures to forces outside themselves—students who feel no personal power.

The teacher can try to help such children shift this "external locus of control" to an internal one through understanding themselves, feeling good about

3. Hans G. Furth, *Piaget for Teachers* (Englewood Cliffs, NJ: Prentice-Hall, Inc. 1970).

4. R. Dunn and K. Dunn, *Teaching Students Through Their Individual Learning Styles: A Practical Approach* (Reston, Virginia: Reston Publishing Co., 1978).

5. M. Ramirez and D. R. Price-Williams, "Cognitive Styles of Children of Three Ethnic Groups in the United States," *Journal of Cross-Cultural Psychology*, 1974.

themselves and their abilities, and assuming more responsibility for learning. Thus, children will be empowered to shape their own future.

## The Learning Environment

The learning environment is more than just the classroom. It is number of factors, with both physical and psychological dimensions, all of which have an impact on learning.

On the one hand, it includes the physical arrangement of resources, such as the furniture, colors, graphic designs, bulletin boards, light, sounds, temperature, as well as books, manipulatives, and other learning media. On the other hand, it includes norms and standards, the decision-making structure in the school, the formal and informal curriculum, relationships between students and teachers, the students' access to resources, and attitudes of the student toward the school and learning.

The classroom environment is really an accurate reflection of the curriculum and the purpose of schooling at that institution. When students enter the room, they can know immediately whether what they are about to learn will be boring or enjoyable. As a result, they may develop a negative attitude of, "So, who wants it?" or they can develop a positive attitude and say, "Let's have more!"

The environment can also characterize the learning experience as intellectually limiting, where the student is expected only to meet someone else's expectations. Sometimes students are faced with prejudged ceilings placed on their achievement, and they in turn accept those limitations, even to the point of developing a low self-concept. In contrast, learning can be perceived as mentally stretching, affirming a student's strengths, building up needed areas, and opening new doors, so that students feel that they can be whatever they want to be.

Teachers who understand the uniqueness of each student can then plan for the most effective learning environment. They can determine what their students are likely to find pleasing and what their students might need or want changed. They can also describe the ideal learning environment in which they would like to teach. Ultimately, it is the teacher's dilemma to try and accommodate the needs of as many different students as possible so that there is maximum learning in the classroom.

Following is a partial list of strategies for improving learning environments:[6]

1. Poll students and listen in a non-judging way to what they say about their environment;
2. Try using "our" rather than "my" when referring to the classroom;
3. Give students some control in managing, decorating, cleaning, and organizing the classroom;

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6. Bessie C. Howard, *Learning to Persist/Persisting to Learn* (Washington, D.C.: Mid-Atlantic Center for Race Equity, The American University), at press.

4. Spend some time in individual conversations with each child on a regular basis, showing that you care and reiterating the high expectations you have for him or her;

5. Affirm the gifts and talents of each child by displaying excellent work or unique approaches, and encourage creativity;

6. Provide opportunities for children to work cooperatively while learning;

7. Be sensitive to overdoing a competitive atmosphere;

8. Praise *effort*;

9. Use variety in modes of instruction;

10. Provide challenging activities such as a "Problem of the Week," posted and unveiled on Fridays;

11. Set aside an area where children can select their own activities, puzzles, books, and games, and these should be not just reserved as a reward but be regularly accessible;

12. Present role models from the community;

13. Be prepared and organized, use time productively, and practice new skills

14. Provide "feedback" to students as soon as possible;

15. Hold regular discussions about the future, such as "What if. . ." or "How will I be when. . .," where the focus is not on giving the "right" answers but on encouraging aspirations;

16. Avoid inequitable rewards and double standards;

17. Be careful when making assumptions about a student's motives without investigating the facts; and

18. Admit that you are human and make errors, have feelings, and are aware of the limits to your knowledge.

Studies on effective schools have shown that learning increases when teachers pay attention to the learning environment. Students become empowered to shape their personal and intellectual growth, develop persistence, become aware of new horizons, and learn how to learn. Attendance improves, and discipline problems decrease.

This is not some distant utopia. It can be the reality in every classroom.

## Curriculum Development

A curriculum consists of all those activities and resources that are provided by the school to make learning possible. This includes not only activities but also the way in which things are done; it is the process as well as the content. Many times, however, teachers are not aware of all the dimensions of a particular school's curriculum and the impact those elements may be having on a child.

A careful examination of a curriculum and its effects will probably reveal a number of issues that can give rise to concern, and these issues may be part of a national problem or they may be unique to a particular institution. Non-Asian minority students may demonstrate low achievement in mathematics, as they do nationally. Students and techers, generally, may dislike mathematics. Mathematics may be isolated from other subjects being taught. There may be outdated or obsolete approaches to the teaching and learning of mathematics.

Instruction may not be appropriately related to the developmental levels of the children in question. An overemphasis on mastering computation skills may act as a barrier to opportunities for learning other mathematical concepts.

Yet, teachers need not examine their curricula in a vacuum. They may draw from the recommendations of professional associations in order to have a context for this review. Two such organizations that have made recommendations in elementary and middle school mathematics curricula are the Conference Board of the Mathematical Sciences and the National Council of Teachers of Mathematics.

The Conference Board, in its 1982 report, made three recommendations. One was that calculators and computers should be introduced into the mathematics classroom at the earliest grade practicable. Both, however, should be utilized to *enhance* the understanding of arithmetic, geometry, and problem-solving techniques. Second, substantially more emphasis should be placed on developing skills in mental arithmetic, estimation, and approximation. Substantially less emphasis should be placed on paper and pencil execution of the arithmetic operations, which can act as a major barrier to thinking and dealing with new situations and new conditions. Third, students should become familiar with the techniques for collecting and analyzing data, which can be demonstrated by studying such things as temperature, absences, teacher behavior, and class statistics.

The NCTM also issued recommendations for the 1980s.[7] These included the following: focusing on problem-solving, expanding the definition of basic skills to include more than computation, utilizing calculators and computers, establishing standards of effectiveness and efficiency for teachers, relying on evaluation techniques beyond conventional testing, increasing the quantity of mathematics being taught to all students, encouraging a high level of professionalism for mathematics teachers, and providing a higher level of public support.

One of the important aspects of planning any mathematics curriculum is to include the use of manipulatives. This is an activity that is supported by research, showing that manipulatives do make a positive difference in learning mathematical concepts.[8] Their function is to bridge the gap between the abstract and the concrete. All students can gain from handling concrete objects before moving to abstract concepts, and the use of manipulatives eliminates the need for a great deal of remediation. If manipulatives are used, it is recommended that a three-step process be incorporated into the curriculum: first, demonstrate the concept with students using the manipulatives; second, use drawings of manipulatives or concrete objects as visual aids for the problems to be solved; and third, then work in the abstract with symbols. At the elementary level, the third step may take some time because students generally are not at that level of intellectual development. It is recommended

7. National Council of Teachers of Mathematics, *An Agenda for Action: Recommendations for School Mathematics for the 1980s* (Reston, VA: N.C.T.M., 1980).

8. National Council of Teachers of Mathematics, "Focus Issue: Manipulatives," *Arithmetic Teacher*, Vol. 33, No. 6, February 1986.

that in addition to structured time spent with manipulatives, students should be allowed open-ended time, where they can explore the manipulatives on their own.

Reviewing a curriculum need not be a complex task, although progressing through the various stages of curriculum development may be time consuming The process begins by identifying the types of students for whom the curriculum is being designed. This can be accomplished by observation and by giving a written pretest to determine the students' personalities, learning styles, culture, interests, achievements, and abilities.

Based on an analyses of these data, it is possible to start writing the goals, which are major outcomes the teacher expects the children will achieve or behaviors the children will be expected to acquire. Goals are stated in general terms, such as: "Students should be able to do all four of the basic arithmetic operations with fractions."

In order to reach these goals, specific enabling objectives must be identified, and those objectives can be further broken down into even more discrete objectives. The objectives should be stated in very specific and measurable behavioral terms. It is not enough, for example, to say merely that the child should "understand." What does that mean? Should the child be required to make a list, to identify material that is provided, or use the given material in some manner?

In each instance, the behaviors should be demonstrable to the teacher. They should be accompanied by a clear statement of the conditions under which the task should be completed, as well as the level at which the child will be expected to perform. Then the objectives should be ranked in a logical sequence that promotes maximum comprehension at each stage.

One objective that tends to be omitted is the exploratory one, which does not fit the mold described above. It is important to give children the opportunity to explore situations or materials where the teacher really does not know what the specific outcome will be. Explorations may lead to new insights or awareness, new attitudes, career aspirations, the integration of content, or feelings of confidence and enjoyment of mathematics.

An analysis of the cognitive pretest will indicate where the sequence of instruction should begin. The teacher must feel satisfied that the items on the pretest are in fact compatible with the behavioral outcomes in the objectives. Furthermore, the enabling activities selected for instruction must actually help learners to achieve the objectives.

At this point, it is appropriate to try and validate the hierarchy of goals and objectives by trying the curriculum and a small sample of children to see if the original assumptions made in designing the curriculum are correct—in other words, see if it works.

When the students have had an opportunity to work with enabling activities, it is important for teachers to be able to determine whether or not the instructional objectives have been achieved. While the post-test meets this purpose, relying on only one way to make the assessment is not enough. Multiple items result in a better indicator of whether the objective has been achieved. Multiple modes, too, are also necessary, and these include listing, describing, writing, solving, and identifying. Each of these should match the outcome specified in the objective.

Finally, this post-test (generally another form of the pre-test) must be examined for its compatibility with the objectives. Using several items for each objective should help to determine more accurately if children in fact achieved those objectives. It is here that teachers can check to see if their tests are criterion referenced, testing for achievement of the goals and objectives, or whether they are accidentally testing something else (such as neatness).

If the child still has not mastered a particular concept, the teacher is faced with the question of remediation. What level is necessary? How can it be delivered without merely repeating verbatim the initial instruction? More importantly, the teacher must decide how the initial method of instruction might be changed or adapted so that the need for remediation is kept at a minimum. Once a child has been put into a remedial process, it is virtually impossible for that child to catch up with the regular program of instruction.

In essence, the whole process is one of recognizing who and where the students are, where they are expected to be at the end of the period of instruction, and what must be done during the process to realize those goals.

## Developing Enabling Activities

Learning experiences that are designed to make it easier for students to achieve curriculum objectives can be called "enabling activities," and a wide variety of these activities can be utilized.

For example, there could be a demonstration on the use of manipulatives. There are games involving such media as television or a variation of bingo for children. There are games played on boards, made of string, requiring bodily activity, or involving relay. Filmstrips, videotape, overhead projections, pictures, grids, or graphics also can be used. There are home and outdoor activities, such as measuring inside the home or studying geometric shapes in the neighborhood. There are calculators and computers. Programmed material enable motivated students to work at their own pace. School financial activities, like budgets, bake sales, and student businesses are helpful, too. The list is endless.

There are, however, at least two criteris for selecting enabling activities. First, teachers should have more than one activity for each objective, and there should be a variety of modes of instructional activities, such as mixing filmstrips, puzzles, and games. This permits students to have a choice, as much as possible, depending on whether their learning style is more visual, auditory, or tactile. Freedom of choice may not always be possible, since children may, at times, need some direction that is based on the teacher's breadth and depth of knowledge about what is appropriate.

Second, activities should be appropriate for the developmental level of the students being taught. If, for example, the children are ready to move out of the concrete stage, they should be allowed to pursue the transition to more symbolic or abstract levels, without the teacher pushing harder than the student is able to handle.

## Integrating Math in Curricula

To overcome a widespread dislike for mathematics, all teachers, not just mathematics teachers, have a responsibility to demonstrate how mathematics is an integral part of other areas in the curriculum, whether they be art, music, science, social studies, English, or others.

One teacher-training model, known as MICA (Mathematics in Content Areas), relies on a thematic approach to this type of teaching.[9] There are basically two approaches to MICA. A teacher can take a particular activity and demonstrate its mathematical content, or the teacher can start with mathematics and show how the various other disciplines relate to it.

With the first approach, the teacher would pick a theme in which children have an interest, such as cars, the zoo, their neighborhood, the city, how they spend their time during the day, or their class in school.

If, for example, the zoo theme is selected, each child can be given a different project related to going to the zoo. There will be greater opportunity for learning if the focus of the experience is limited to one animal and one aspect of mathematics. If the animal chosen is a bear, and the mathematics activity is measuring, the students can be asked to find answers to the following questions:

How much food does a bear require? What does that food cost? What does it cost to maintain all the bears and how much for each bear? How much space does a bear, or bears of different sizes, require? What is the size and shape of the containers in which a bear is kept? How long does the bear live? What are its cycles for reproduction and growth? How big does a bear get?

With the second approach, the teacher can show how mathematics is important in various subjects. In social studies, for example, mathematics is necessary to use a map kep and measure the distance between points on a map; or in science, to construct a model of the planetary system; or in music, to describe notes, measured silence, scales, and meter in scores; or in art to identify and create geometric shapes, then use them in a design.

Attitudes toward mathematics can be changed if students make the important linkages with enjoyment and survival. The leadership for change must come from teachers who are themselves appropriately sensitized to the needs of their students, to the subjects they are teaching, and to the world around them.

## Math Anxiety

Math anxiety[10] is a fear of, dislike for, phobic reaction to, and repulsion for mathematics and math-related activities. It is a communicable "dis-ease" whose victims range along the continuum from having a mild reaction to being violently ill. Nevertheless, it can be both cured and prevented.

9. Bessie C. Howard, *Mathematics in Content Areas (MICA): A Teacher Training Approach* (Washington, D.C.: Howard University Teacher Corps, 1978).

10. Sheila Tobias, *Overcoming Math Anxiety* (New York: W.W. Norton & Co., Inc., 1978).

It is frequently caused by teachers themselves, as well as other adults. There is also some conditioning by society as a whole, suggesting that mathematics is meant for males, studious people, and so on. Children can sense these biases, internalize them, and assume the behavior that they think is expected of them.

The process is actually cyclical. When a person has an encounter with a mathematics experience, numerous irrational beliefs or myths begin to rise to the surface. The experience is interpreted through these filters that are constructed from past experience. The person may say, "I can't do math," or "It takes a mathematical mind to do that," or "I'm lucky if I get it," or "You need a good memory," or "It's a white man's field." This produces stress, which can be manifested as anxiety, fear, panic, or even pain. The individual then responds with avoidance, withdrawal, failure, and a poor self-image.

The effect on society is that there is a lack of positive role models for excellence in mathematics, people have low expectations for themselves and others, and young people are sometimes counseled not to pursue math-related careers. All of this, in turn, reinforces the beliefs that to some extent are part of everyone's inventory of myths.

To help students learn mathematics, teachers must become sensitive to these possibilities, and the process starts with the self. The teacher must become aware of his or her own unfavorable biases and feelings that might not be helpful, then try to exhibit only positive behaviors. Instead of saying, "I was lucky to get that answer," say, "I did that because I *understood* it. If I can do that, I can take the next step."

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She was a secondary school mathematics teacher and a curriculum specialist for a number of years. She was an Associate Director of the Howard University Teacher Corps Program, as well as Assistant Director for Mathematics Resource Development in the D.C. Public Schools.

Her special concern to MATH Alive! is her commitment to training teachers to bring the best out in students.

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# From the Teachers' Desks: Notes on Classroom Management

*Two aspects of the "MATH Alive!" experience were important sources of information about how teachers in independent neighborhood schools manage their classrooms. These were the discussion periods during lectures and the learning teams.*[1]

*The following notes are from some of the comments made by teachers as they reflected on strategies they utilize to manage their own classrooms.*

## Activities

- One high school has created an "activity hour" to break up the day. Students engage in learning activities like the math club, science club, French club, etc., and the program is kept within the competency goals established by the State.
- Role playing (such as buying, selling, mental estimation of profits and losses, and counting change), as well as participating in actual bake sales or income-generating fairs, are important activities for younger children.
- Draw a stick figure on the board, then ask prepared questions of individuals or teams. Each time an incorrect answer is given, have the student erase part of the figure.
- Ask the students to use their family's utility bills (electricity or gas) to compute usage between meter readings, find averages, and perform other analyses.
- Create games modeled after television contests. For example, the teacher can use flash cards with prices of items, then ask the students to write down the factors needed to arrive at the price.
- Team learning activities are important, too. Children can be divided into groups where one student can help another student, because sometimes children will listen to each other more than they will listen to the teacher.

1. Learning Teams were groups of teachers who met informally, at regularly-scheduled day and evening sessions and on an *ad hoc* basis. Team members supported each other in the learning experience as they clarified their individual learning goals, had free expression of their feelings and thoughts, confronted each others' opinions, generated new ideas, and explored the seminar content in greater depth.

## Affirming Gifts and Talents

• Students who can draw can be asked to help decorate the classroom or do a motivational type poster or cartoon for display in the classroom. Those who print neat letters can do posters for candidates to elected student government positions. Teachers should also not overlook students who are very quiet or who appear hyperactive, for they may be the best prospects whose talents need to be affirmed.

## Course Structure

• When math is being taught and the students become so engrossed and motivated, giving the teacher considerable input on a particular concept, it is not always easy to move on to another subject. Some teachers will close out a discussion by saying, "We haven't finished this subject, but we'll continue this tomorrow," and give them an assignment based on what has been covered up to that point.

• Greater flexibility in restructuring class periods may be possible when students are assigned to a permanent classroom, instead of being required to move to another room at the end of the period, and when the same teacher must teach several subjects. Some teachers find it better to allow the mathematics period, for example, to use some of the time allotted for social science and spend less time with mathematics on the following day. They have found that class discussion of one subject can be adversely affected, for as much as 15 minutes, if the previous class or subject was terminated while the students were still deeply involved in that subject.

• Sometimes curricula must be rewritten so that important elements are not neglected. For example, some teachers do not teach much geometry because it is difficult to get past the basics. They recommend separating it from mathematics, just like geography should be separated from social studies.

• Always map out a detailed lesson plan and try to stick to it. It even helps the class if the teacher puts the day's goals and objectives on the blackboard.

## Discipline

•The worst troublemaker is the child who needs a teacher's help more than anybody else. Pull him aside and talk to him. Find out what the problem is. There are some problems teachers don't even know about, and it's usually at home. The child who "acts up" the worst needs you the most.

• Being prepared for the day's class, structuring "free" time, and maintaining the flow from one activity to the next are very important. Children can spot when the teacher is unsure about what to do next. They will jump into that little space, and the teacher will lose control.

• Rules should be posted, but more importantly, students should become a part of making the rules for "their" room. They will not only follow the rules more closely themselves, but they will usually pressure their peers to conform, without intervention by the teacher. Rules also should be written out and given to the parents. Teachers must be consistent, however, in their applying the rules, for negating a rule "just this one time" can undermine the entire process.

• It may be helpful to plan bathroom breaks, especially in the seventh grade, and announce the times in advance so that children can anticipate when they will be free to go. On the other hand, if children have the freedom to excuse themselves at any time and leave the room, they should be held responsible for anything that happens while they are away.

• In one school, a child who violated a rule was put on trial in front of the whole class. The children learned the vocabulary of the courtroom, appointed a stenographer, a bailiff, and a district attorney. The child on trial had to find his own attorney. Students, teachers, and the principal were subpoenaed as witnesses. The class was graded for the exercise, and the district attorney who won the case got the top grade. They learned how to stand up before their peers and be involved. Serious discipline problems throughout the entire school were eliminated, for that year and for subsequent years, because the students always talked to each other about the experience.

• Arguing back to students is a very ineffective way to maintain control. If a student is argumentative, it is much better for the teacher to talk in a quiet, confident, relaxed tone, "Would you please sit down so that we can talk about it?" (However, *both* teacher and child must sit. Otherwise, the person who remains standing is in a more intimidating position.) Then say, "What is your problem?" "What can we do about it?" or, "How can we go about changing you (or me, or us)?" A similar approach works with upset parents, too.

## Incentives

• Most teachers agreed that some tangible incentive for good performance is necessary, but teachers differ on the type, frequency, and purpose for incentive awards. For example, some give stars at the end of the week, others use rubber stamps, stickers, used books, or inexpensive party-favor type of toys. Some give awards only for "A" work, while others also reward effort and progress, such as for "the most improved" student.

• One teacher collects class dues of 25 cents per person, per week. This money is used to buy awards for children (as individuals or as teams) who win curriculum-related contests that are held on Fridays.

• Sometimes games can get noisy. If someone speaks out of turn or gives the answer away, that person's team can lose points. This teaches them to respect what others are doing.

• Another teacher has developed a scoring system, awarding a certain number of points per day for certain activities. In addition, children set their own goals for self-improvement (e.g. practicing self-control or bringing in homework on time), and they earn points for meeting their goals. Each person who earns all the required points for an initial period of accountability is given a complimentary letter, signed by the teacher, to take home. For cumulative improvement over a longer period of accountability, the incentives or awards can be greater.

## Report Cards

• One school has divided the school year into trimesters, each with three months. Report cards are issued at the end of each trimester. However, the reports are not sent home with the children; the parents must come in and discuss with the teachers the progress their children are making.

## Test-taking

• Some schools set aside one period a week to build test-taking skills, followed by two practice examinations each year.

## Understanding Systems

• It is not enough to buy a commercially-available kit and assemble the parts to demonstrate a concept to a class. It is far better to teach children, from the ground up, how systems evolve from raw material—even to the point of getting supplies from the custodian and soldering pipes together. Children should not be satisfied to experience life only from finished products, while others understand the foundations of systems, the mathematical aspects of the parts, and how things really work.

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Judy England Howe, *Arithmetic 4, Arithmetic 5* and *Arithmetic 6* (Traditional Math Series);

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Samples of cutouts made with the Ellison Letter Machine, including tangrams and geometric patterns;

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J. Saxon & S. Hake, *Math 76, Algebra ½, Algebra 1*;

John H. Saxon, Jr., *Algebra II: An Incremental Development;* and *Geometry, Trigonometry, Algebra III: An Incremental Development.* (Provided by the author, who also wrote, "The Way We Teach our Children Math is a Disgrace," *American Education,* Vol. 20, No. 4, May 1984.)

JAMIA Consultants Cooperative, Box 236, Lansdowne, PA 19050

M. Marefu, *Introduction to Community Building and Learning Technical Skills* (Includes mathematics "from an Afrikan frame of reference.")

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Zaslavsky, C., *Africa Counts: Number and Pattern in African Culture* (A documentation of the contribution of African peoples to the science of mathematics)

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*Second International Mathematics Study: Summary Report for the United States*

Portland Public Schools, Curriculum Department, 501 North Dixon Street, Portland, OR 97227

Beatrice Lumpkin, *African and African-American Contributions to Mathematics,* May 1986 (Pre-publication copy of baseline essay for the Multnomah School District 1J); and

Hunter Havelin Adams III, "African and African-American Contributions to Science and Technology," August 1986. (Pre-publication copy of baseline essay for the Multnomah School District 1J)

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