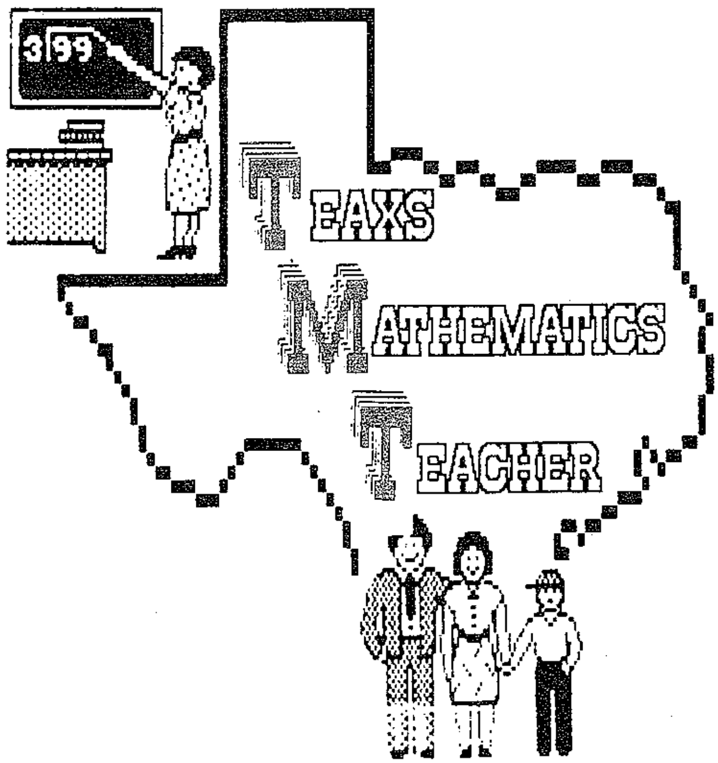

Starting the Creative Juices

Math-Dodgers: The Secretary

Volumes of N-Gon Based Boxes

Mathematics Communication in the Elementary Classroom

When is a "C" not a "C"?

MARCH 1993

TEXAS MATHEMATICS TEACHER, the official journal of the Texas Council of Teachers of Mathematics, is published four times each year, in October, January, March, and May. All manuscripts and editorial correspondence should be addressed to George H. Willson, listed above.

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SUBSCRIPTION and MEMBERSHIP information will be found on the back cover.

TEXAS MATHEMATICS TEACHER

TEXAS COUNCIL OF TEACHERS OF MATHEMATICS

Affiliated with the National Council of Teachers of Mathematics

March 1993

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President's Message

Do you ever think about that very special teacher you had in school...the one who brought out the best in you? Mine was Miss Ifollo. She was my fifth grade teacher in Park Forest, Illinois. Miss Ifollo made every day in class an exciting experience. I can still list the Presidents (at least through Eisenhower) and recite the capitals of 48 states! When I ask myself why I became a teacher, I often think of her.

Two years ago I was at the University of Chicago for a summer institute. I decided to try to locate Miss Ifollo. I had not seen her since 1959. Through a series of phone calls and help from a variety of people, I was able to find her and we met for lunch. She arrived with a list of the 30 students who had been in my class and was able to tell me what several of them are doing now. She was still teaching, and using summers for travel and educational pursuits. Time flew as we had a lively conversation about the past 31 years and our mutual love of teaching. She was just as dynamic as I remembered she had been when I was in her classroom. I was able to let her know that she has been the "very special teacher" in my life. She recently wrote that she will be retiring from the teaching profession in June...and in September she will begin a degree at the University of Chicago!

As teachers, we all know how wonderful it feels to be appreciated for the work we do. It may be a former student who returns to say thanks or a colleague who lets you know that he values what you are doing. There are several outstanding opportunities that each of us have to honor fellow teachers. Nominations for the Presidential Awards for Excellence in Science and Mathematics Teaching are accepted every December. Winners receive a visit to Washington D.C. and their school receives a $7500 grant to improve math and science. The Christa McAuliffe Fellowship Program nominations are due each April. Through this award teachers are eligible to receive 100% of their salary for innovative projects or sabbatical study. The Texas Teacher of the Year nominations are due to regional service centers each April. Regional winners receive $500 from Southwestern Bell and are eligible for state and national selections. Additional information about these awards is available from district superintendents, regional service centers, or TEA.

We have been inspired by teachers who have taught us, and by teachers we see teaching others. As mentors and role models, these people are an important influence on us. Take the time to thank a teacher who has been an inspiration to you.

Susan Thomas
TCTM President

R C D P M . . . .
Research Council for Diagnostic and Prescriptive Mathematics

THE 3 E'S OF MATHEMATICS: EMPOWERING THROUGH EQUITY IN EDUCATION

21st Annual Meeting

February 10-12, 1994
Radisson Plaza Hotel
Fort Worth, Texas

CALL FOR PRESENTERS

The Twenty-first Annual Meeting of the Research Council for Diagnostic and Prescriptive Mathematics will focus on student populations that are presently underserved or under-represented in the field of mathematics. These special populations include minority, at-risk, ESL, learning disabled, and female students. Other topics that might be of interest to mathematics educators are also welcomed. All topics, however, must be directly related to the mission of the RCDPM.

RCDPM Mission: To stimulate, generate, coordinate and disseminate research efforts designed to understand and overcome factors that inhibit maximal mathematics learning.

Research or dissemination reports and general interest sessions are to be scheduled for the conference. Workshops, poster discussions, and presentations will be the available formats.

To request more conference information or a proposal submittal form, please contact Frances M. Thompson, Program Chair, at 2946 Housley Drive, Dallas, TX 75228, or call her at work (817/898-2166) or at home (214/681-4184).

PROPOSAL SUBMISSION DEADLINE: JUNE 1, 1993

STARTING THE CREATIVE JUICES

Joe F. Allison

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What does it mean to be creative? C.S. Lewis, a famous and creative British author said that it is something not easily described. He said that it is impossible for your brain to watch your brain being creative when it is creating.

So, instead of trying to answer the question, let us demonstrate an act of creativity. For an example, we turn to a prince of creativity, Gauss. As a youngster, Gauss noticed a pattern that gave him an insight for solving an arithmetic problem that has since found use as one litmus test exposing mathematical aptitude:

"Sum the first one hundred positive integers."

Gauss, it is thought, applied the commutative property of addition, and noticed:

$$1 + 2 + 3 + \ldots + 98 + 99 + 100 = S \qquad (1a)$$

$$100 + 99 + 98 + \ldots + 3 + 2 + 1 = S \qquad (1b)$$

$$101 + 101 + 101 + \ldots + 101 + 101 + 101 = 2S \qquad (2)$$

$$100(101) = 2S \qquad (3)$$

$$\text{Therefore, } S = 50(101) = 5050\ . \qquad (4)$$

Gauss apparently was able to get to line (3) "in his head," and then he was able to arrive at line (4), also "in his head."

Gauss's creative insight here is well known; so, we will try to search out a different pattern that under similar circumstances will still be as convenient.

But first, we note that one method of creatively attacking a problem is that of setting aside the given problem and solving a different one. See the article cited in the reference bibliography by Kenyon and Boone for an exposition of single dimension problems that are solved readily by conveniently changing the problems to two-dimensional ones. To exhibit this, as one example, consider an inequality problem associated with a subset of the real number line: $x^2 + 6 > 5x$.

Equivalently, we have: $x^2 - 5x + 6 > 0$; and, the problem is now restated as: What real number choices cause the expression $x^2 - 5x + 6$ to become positive?

A creative step occurs as the problem in a single dimension is changed to probems in Euclidean two-space:

(a) What does $y - f(x) = x^2 - 5x + 6$ look like in graphical form? And,

(b) Where are the y's positive?

We observe that $y = f(x) = (x - 2)(x - 3)$ is an equivalency for this "up opening" parabola and conveniently helps provide the graph in Figure 1.

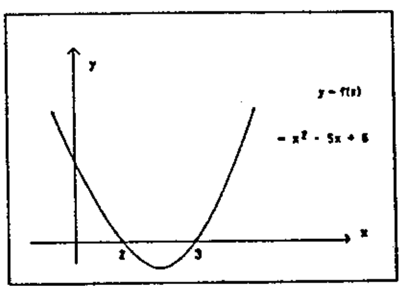

Figure 1

We are able to "see" from Figure 1 that the solution set is the result of: $x < 2$ in union with $3 < x$.

Returning to Gauss's arithmetic problem, we conveniently set ourselves this problem: Is there a compact way to add the first $\underline{n}$ positive odd integers? I.e.,

$$1 + 3 + 5 + 7 + \ldots + (2n - 1) = (?).$$

We note that:

$$1 + 3 + 5 = 9 = 3^2; \text{ and,}$$

$1 + 3 + 5 + 7 = 16 = 4^2$; and, by inductive reasoning, anticipate that:

$$1 + 3 + 5 + 7 + \ldots + (2n - 1) = n^2. \quad (5)$$

(Showing that this is true, by the way, is a good experience in Inductive Proofs, but it is not our present concern.)

At this point we look for a convenient pattern.

Observing that each positive odd integer has the pattern $2(n) - 1$, we see that equation #(5) may be restructured on the left hand side as:

$$2(1) - 1 + 2(2) - 1 + 2(3) - 1 + \ldots + 2(n) - 1 = n^2.$$

Regrouping on the left produces:

$$2 + 4 + 6 + \ldots + 2n - (1 + 1 + 1 + \ldots + 1) = n^2.$$

With $\underline{n}$ addends of one, the arithmetic expression in parentheses on the lefthand side collapses and we have:

$$2 + 4 + 6 + \ldots + 2n - (n) = n^2; \text{ or,}$$

$$2 + 4 + 6 + \ldots + 2n \qquad = n^2 + n = n(n+1).$$

Multiplying on both sides by one-half produces

$$1 + 2 + 3 + \ldots + n = (n(n + 1))/2.$$

So, we reach a famous compact righthand-side that is a convenient expression for a generalization of the sum of the first n positive integers.

This article then has exhibited Gauss's insight into special series summation and provided another exhibition of at least one other important method employed by mathematicians; that is, the setting of different, but related problems which can afford insightful pattern recognition and convenience in arriving at solutions of the original problems.

REFERENCE

Kenyon, D. and J. Boone, "Using an algebraic/geometric approach to solving equations and inequalities," Texas Mathematics Teacher, Vol. XXXVIII (1), pp. 4-11, 1991.

MANUSCRIPTS NEEDED

Manuscripts should be neatly typewritten and double spaced, with wide margins, on 8 ½" X 11" paper. Authors should submit the signed original and four copies. Illustrations should be carefully prepared in black ink on separate sheets, the original without lettering and one copy with lettering added. As soon as possible after refereeing, authors will be notified of a publication decision. Originals of articles not accepted for publication will be returned to the authors. Two copies of the issue in which an author's manuscript appears will automatically be sent to the author.

MATH-DODGERS: THE SECRETARY

Glenda Wood

University of Mary Hardin-Baylor
Belton, Texas

I will not learn this math.
I see no need for it.
For I'm to be a secretary
So behind my desk I'll sit.

I will not use these fractions.
Denominators should repeat.
My major expectation
Will be to smile and greet.

No math is used in typing.
When margins must be found
I'll guess until I get them right
And never move them 'round.

No business uses algebra.
We solve for no unknown.
The only x's around here:
Divorced spouses, now long gone.

On decimals and minutes:
The relationship won't fit.
If I err on time sheets--
Oh, they won't mind one bit.

For it seems to me impossible;
(It'd take an Einstein-scholar)
To equate the minutes to an hour
To the pennies in a dollar.

So I'll just push my underlings,
No fractions or addition.
To try to figure overtime
Is just out of the question.

Uh oh, the boss's birthday's near.
And I didn't learn division.
I'll pass the hat and pay what's left.
(It's the price of math omission.)

I will not learn this math.
I've shown no need for it.
For I'm to be a secretary
Just behind my desk I'll sit.

5X²-5
8.75 (3X -1)
6.89
10X³ + 2X - 7

VOLUMES OF N-GON BASED BOXES

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Probably all standard Calculus texts have problems such as; suppose that from a b by b square piece of material, an x by x square is cut from each corner, and the sides are folded upward forming an open top box. Determine X so that the resulting box has a maximum volume (the solution is X - b/6).

In this note, the above problem will be extended to the case where the original piece of material is in the shape of a regular n-gon whose sides are of length b. It will be shown that the length cut from each side at each corner (in this case, a quadrilateral is removed from each corner) is also B/6; that is, the length of the cut made along each side of the n-gon is independent of n. In addition, the depth of the cut will also be determined.

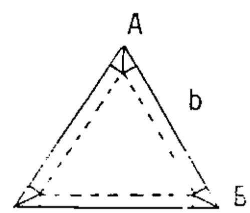

Figure 1

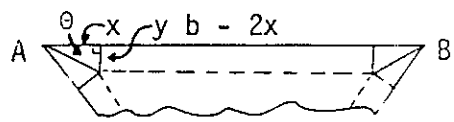

Figure 2

Theorem Let G be a regular n-gon whose sides are of length b. Quadrilaterals are cut from each corner (see Figures 1 and 2), and the sides are folded upward to form an n-gon based box. For a maximum volume of the resulting box, the quadrilaterals should be cut so that $x = b/6$; furthermore, the depth of the cut is $y = (b\tan\theta)/6$, where $\theta = (n - 2)180°/2n$.

Proof The area of a regular n-gon with sides of length s is $(n/4)\cot(180°/n)s^2$ (I found this formula in my trusty CRC Handbook); hence, the volume of the box formed is $v = (n/4)\cot(180°/n)(b - 2x)^2y$. Now, from Figure 2, $y = x\tan\theta$. Substitution for y, and simplification yields $v = Kx(b - 2x)^2$, where $K = (n/4)\cot(180°/n)\tan\theta$. The critical values of v are b/2 (which yields $v = \theta$) and b/6, which yields the maximum v.

Now, as for y; the angle θ is one half an interior angle. Since the sum of the interior angles is $(n - 2)180°$, and there are n angles in an n-gon, θ is $(n - 2)180°/2n$. From the above, $y = (b\tan\theta)/6$, yielding the desired result.

Note that, of course, only in the case where the regular n-gon is a square, will the depth of the cut, y, equal the length of the cut, x; in this case $\theta = 45°$.

MATHEMATICS COMMUNICATION IN THE ELEMENTARY CLASSROOM

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Editor's Note: This article is being reprinted again due to numerous errors in the first printing, Fall, 1991. It is regretable that this happened.

Curriculum and Evaluation Standards for School Mathematics (Standards) (1989) prepared by the National Council of Teachers of Mathematics (NCTM) advocates that the study of mathematics in grades K-8 should include diverse opportunities for children to communicate about mathematics. Effective math communication, similar to whole language, emphasizes the meaningful exchange of ideas in real-life contexts. Listening, talking, reading, and writing help children construct and clarify their own understandings as well as give teachers valuable information about pupils' thought processes. Unfortunately, mathematics communication activities traditionally have dealt with technical terms and symbols almost exclusively. Other types of mathematics communication (e.g., explaining one's thinking, justifying an answer, describing how a problem was solved) have been used infrequently (NCTM 1989).

Although, most elementary teachers see a need for utilizing motivating communication activities in math class, they may not know how to get started. Following are some examples of ideas to assist teachers in providing children with opportunities to become expressive mathematicians. These ideas may be modified or extended for children of different ages and interests.

1. Math Show and Tell

At a regular appointed time, allow children to demonstrate or tell about something related to mathematics. When first given this assignment, children may exclaim, "I don't have any 'math thing' to talk about." However, after participating in this activity once or twice, they become very creative in selecting their topics. Possible show and tell topics include a toy or game related to mathematics, a map depicting the route/mileage of a family trip, a storybook involving mathematics, a child made chart depicting the child's daily schedule, the nutritional information regarding a favorite cereal, etc.

2. Math Journals

Request that children keep math journals in which they reflect on each day's math activities. Initially, it may be necessary to pose questions (e.g., What was the most important thing you learned today? How can you use what you learned in math today?) in order to guide children to think reflectively; however, this soon becomes unnecessary. Encourage children to record their reflections using pictures, diagrams, symbols, and words. Journals may be exchanged among children on a voluntary basis. Teachers should keep math journals, also, and share their entries with the children.

3. Math Pen Pals

Urge children to correspond with math pen pals regarding what they are learning about math and how they are using math inside and outside of math class. Arrange for pupils to write to children in other schools or other classes/grades within the same school. In the beginning, students may write only short notes to their pen pals, nominally fulfilling the assignment. However, as time goes on, they become enthusiastic about writing and receiving letters, and often spend free time in and out of school working on their letters.

4. Jigsawing

Provide problems for small cooperative groups of children to solve; however, give each group member only one piece of information needed to solve the problem. Consequently, cooperation and communication among children are needed to develop possible strategies and solutions. Encourage all modes of communication (i.e., talking, listening, reading, writing) between group members. Occasionally, utilize a variation of this activity in which children are allowed to communicate only through reading, writing, and drawing.

5. Open-ended Questions

Ask children open-ended questions such as "How should we go about assigning points for our science fair projects?" Children may answer aloud and in writing. Encourage children to consider and respond to each others' answers.

6. Build What I Build

Seat two children next to each other with a barrier (e.g., large book, tall box) between them. This barrier should prevent each child from seeing what the other child is doing. Ask one child to build a structure with blocks or other manipulatives. Have this child describe his or her structure to the other child who must try to build an identical one from their verbal instructions only.

7. Acting Out Problems

Provide groups of children with story problems to solve. Encourage the groups to act out the problems to find solutions. Allow the groups to act out the problems and solutions for other classmates. Interesting problems may be written by the teacher or adapted from problems found in numerous Arithmetic Teacher articles. Also, children may create their own problems to act out. A variation of this game is to allow pantomime only.

8. What Is It?

Ask one child to choose a math manipulative (e.g., Cuisenaire rod, color tile, centimeter ruler) and put it behind his or her back. As the children describe the manipulative aloud, the remaining children try to guess what it is. The winner then chooses and describes the next manipulative. A variation of this game occurs when the guessers ask closed-ended questions (i.e., questions that may be answered "yes" or "no") to gain information in order to guess the manipulative.

9. Math Stories and Poems

Encourage children to create and illustrate their own stories and poems involving mathematics. Stories and poems may be nonfiction (e.g., How I Use the Metric System, Constructing a Kite) or fiction (e.g., (The Martian Number System, What's Square About a Square). Bind children's creative writings in simple books and place them in the class library for independent reading.

10. Math Bulletin Boards

Make groups of children responsible for math bulletin boards on a regular basis. Developing themes, dividing tasks, making materials, and putting up the display requires communication among group members and the finished bulletin board is read and discussed by other classmates.

11. Real-life Settings

Allow groups of children to create real-life settings such as restaurants, stores, and other places of business. Child-created props may include menus, price lists, order forms, etc. As children pretend to be proprietors and customers, they see the need for clear communication about mathematics as they apply it to everyday situations.

12. Surveys

Provide opportunities for children to take surveys and gather other data concerning tastes, interests, and habits of schoolmates and the local community. Ask them to communicate their findings through charts, graphs, oral reports, and written descriptions.

13. Math Newsletter

Let children write and edit a math newsletter. Ideas for stories include children's own math interests, famous mathematicians, community helpers who use math, curious math problems, careers in mathematics, etc.

14. I Spy

Encourage one child to describe familiar objects in the classroom using spatial terms ranging from simple (e.g., above, below, over, under) to more complex (e.g., parallel, perpendicular, at a right angle). Other children listen and/or diagram in order to guess what is being described. Young children may begin with descriptions such as, "something that's a tall rectangle under the exit sign," (door). Older children progress to descriptions such as, "a parallelogram with four right angles measuring about two meters by three-quarters of a meter," (door).

Teachers who have adapted ideas such as these for use in their classrooms report that children's attitudes toward mathematics improve as they participate in communication activities. Children who once viewed mathematics as a rigid, unimaginative discipline now begin to see mathematics as a creative subject with opportunities for self-expression. Through communicating mathematics in novel ways, they discover that math is integrated with other subject areas and everyday life. Consequently, they voluntarily begin to use mathematics outside of math class. As they do this, math-anxious students often become more confident.

In addition, many children improve their achievement in mathematics. As they strive to communicate mathematical ideas to others, they analyze and refine these ideas in their own minds as well as make mathematical terminology a useful part of their vocabularies. Also, as they listen to and read about other students' ideas regarding mathematics, they begin to consider different points of view and learn from each other.

Elementary teachers should utilize these ideas only as a starting point for effective mathematics communication. As they observe children's enthusiasm and enjoyment when engaging in these activities, teachers will undoubtedly discover other ways to foster the meaningful communication of mathematics as a vital part of learning.

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WHEN IS A "C" NOT A "C"?

C. M. Smithwick-Kiebach

Graduate Student
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Suzy Wright averaged 90 on her homework (20%), 70 on her quizzes (20%), 65 on her tests (30%), and 62 on her cumulative exam (30%). Jonny Begone averaged 0 on his homework (20%), 91 on his quizzes (20%), 93 on his tests (30%), and 100 on his cumulative exam (30%). Both of their report cards reported these students as "C" students with 71 averages.

In another situation, quiz grades for Constance Felix were 72, 69, 74, 67, and 73; for Wayne Waxer they were 39, 98, 73, 97, and 48; and for Eli Apt they were 37, 59, 76, 87, and 96. Do these grades (all "C's", all 71's) really reflect the same achievements in the mastery of the subject? If not, how can these grades be refined to show more accurately each student's academic work?

Take a moment to consider for yourself the answers to several questions. Why do you grade? Whom do the grades serve? What do they communicate, and to whom? If two years after a student has left your class another teachers reviews your student's grades, what actions could be taken by that new teacher based on those grades, and what predictions could be made?

What we really value in education and how we reflect those values in the grades we use to communicate with students, parents, and others needs to change. Consider the traditional markings on a 100 point scale; they do not mean the same things when applied to different measures of knowledge. For example, is a 65 on the first assignment on fractions the same as a 65 on the unit test or even on the third assignment? Do your students understand the distinction between an 84 and an 89 on the same test? Indeed, is there really a defensible distinction? How often do you find that the words "well done" or "nice improvement" communicate more clearly what you feel about the work being done by your students? While alternative assessments may not be useful to you in every situation, neither are traditional grades.

The Three-Partition System

One way of communicating with your students is a broad category grading system using only three partitions: "This is what I expected from this assignment" (2 points), "I think something significant has been left out of this assignment" (1 point), or "I recognize a significant addition has been made to this work" (3 points). No points are given if the work is not done, but nothing is removed if a less than perfect effort is made. The idea here is to reward **every** attempt and the encourage **each** student to try.

By starting with nothing and gaining points, rather than starting at 100 and losing them, you are judging your students on a totally different basis. You are acknowledging that they needn't be perfect to be appreciated, nor do they need to know everything to be learning. When a finer distinction needs to be made, each of these three categories can be broken into halves to create a 6 point scale.

Rather than the marking being the end of the dialog on the work between you and your students, you will find that this format opens the door to productive conversations that start like these...

Sarah: Joe, you got a 3! What else did you find out about quadrilaterals?

or

Marik: May I look up these functions again to see what I left out?

By communicating to these students a clear message of your opinion of their work, they become more interested in **continuing** the discussion than in **accepting** an arbitrary percentage tag on their work. The arguing over allocation of partial credit gives way to real concerns about what information was needed or what was added.

Another way to use this 3 point system is to allow both peer assessments and self assessments. In peer assessment one or more students make **and defend** their assessments of the work they are reading. On a separate paper they record the name of the person being reviewed, the reviewer(s)'s name, and the reasoning for the category assigned. In this case each student sees the work not only through his own interpretation, but also through the eyes of several others. The peer papers are then either turned in with the original work to be included with your own assessment or returned to the students for their further work on the critiqued assignment. The original, the reviews, and the corrected work can then be presented to you as a whole package.

In self assessment, a group discussion of the processes and answers is conducted before the students decide how well their own work reflects the group consensus. Again, a critical issue is the defense of the marking. When students can explain what is missing from their work or what has been added or why the work is what was expected, they have internalized the ideas presented in an entirely different way from when they originally worked out the answers.

These assessment techniques do not alter the standards of what is to be taught, nor do they lower the expectations of what constitutes mastery of the material. They do not need to replace cumulative evaluations of the total material mastered and retained, although for certain subjects and occasions they could. What they can do for most teachers is to allow for a more direct communication with students as the students progress through the materials and into their own understanding of the material.

<u>Application of the System</u>

How would our five students do under this system? Consider Suzy Wright and Constance Felix again. Each girl kept a log of the things that were missing from her assignments. As the lists grew, Suzy identified her weakness as being lack of speed. When she could work without time pressure, she could perform as expected, or at the 2 level. Constance Felix found that she routinely missed problems if she did not have a clear mental picture of the question before she started working. By drawing or using manipulatives on problems, she was able to add significant insights to several of her assignments thereby earning the recognition of a 3.

Eli Apt didn't really have any problem with his work; he simply didn't have the same background that some of the others had. When he was graded based on expectations and progress, it became clear that he had achieved excellent mastery of each concept by the conclusion of the unit and was making intriguing connections to several sports situations. He started most units with 2's, but quickly moved into the 3 category.

Jonny Begone and Wayne Waxer were able to track for themselves their on again, off again performances and isolate the causes. For Jonny his after school job was more important to him than doing homework over material he already understood. He volunteered to replace his homework time with a half hour of peer tutoring before school for anyone who needed the extra help. He quickly learned to use questions (rather than obvious hints about the answers) with his friends to help them gain their own insights. These sessions were considered automatic 3's since he was certainly "adding significantly" to each assignment he was able to teach. Wayne found the looser system more motivating to him. He became more interested in turning in a consistent effort, because as he said, "Now I know what you want."

Is this a cure-all? Of course not, but it does change everyone's perspective on the work requested. It allows for the daily fluctuations in adolescent behavior and for the many external pressures which shadow the school day. To acclimate to it takes time for everyone; but once it is in place, it seems to validate more strongly and to personalize the grading system in the student's eyes. Perhaps its most significant asset is the strongly positive, nonthreatening atmosphere it promotes in the classroom.

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