

Morgan State University  
*Department of Mathematics*  
MATHEMATICS COLLOQUIUM

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**Dr. Jerome Dancis**

University of Maryland College Park

*K-12 “Pretend Mathematics”  
Curriculum Produces Freshmen  
Who Know Less Algebra*

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**ABSTRACT:**

- $2x + 3x = 5x$  omitted from MD state HSA (exam) on “Pretend” Algebra and “Pretentious” Data Analysis.
- Pretend Arithmetic: MD state K-8 Math curriculum marginalizes Arithmetic while over-using calculators.
- Pretend Arithmetic Word Problems: Avoid two-step problems.
- Pretend Euclidean Geometry produces students with little sense of valid arguments.
- Consequence: Serious drop in number of entering college freshmen competent in Arithmetic and Algebra. (All ethnicities.)  
Chart at my Math Education Website: [www.math.umd.edu/~jnd](http://www.math.umd.edu/~jnd)

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Refreshments will be served.

## Pretend K-12 Mathematics Curriculum Produces Freshmen Who Know Less Algebra

### Dr. Jerome Dancis (UMCP)

My child, in the 1980s fast academic track, was taught one third *less* mathematics in high school than I was in the 1950s standard academic track. Serious training in deductive proofs of theorems and in word problems and Solid Geometry had *disappeared* from the current curriculum. There was much Reform in last 20 years, producing even less learning.

The high school Euclidean geometry course was a deductive-proof-of-a-theorem each day math course, which provided students with a sense of logical reasoning and deductive logic. No more; about 1970, 100 theorems became postulates; their proofs disappeared.

In "A Plea in Defense of Euclidean Geometry: Fewer classes require proofs--more whittling away of exposure to logic and critical thinking", Barry Simon, Math Dept. at Cal. Tech. noted "what is really important [in math education] is the exposure [of students] to clear and rigorous arguments ... [so that] they can more readily see through the faulty reasoning so often presented in the media and by politicians". If students received a more exposure to logic they would also have less difficulty adjusting to and understanding college courses.

### Proof by Checking Three Cases is Pretense Rigor.

Harel wrote: "I have worked intensively with junior-high and high-school teachers. These teachers [have an] absolute reliance on pictures and patterns. ... Once the teachers observe a "pattern" (from two or three cases) or draw a picture, they derive the final conclusion empirically or perceptually. There are almost no attempts to support and supplement their empirical and perceptual reasoning with algebra." (math education professor)

**Popular Problem.** Look at the pattern: 0, 2, 4, 6, 8, . . . If the pattern continues, what will be the next term? (From MD HSA on Algebra booklet introduction.)

The subject content certification requirement for a HS teacher is 36 college credits in the subject (at least 12 credits in jr.-sr. level courses) – *teacher's choice*. Then the teacher must pass the Praxis II exam, which *omits* knowing why  $(-1)(-1)$  is defined as  $+1$ .

A fully certified MD HS math teacher need NOT have taken a Geometry course in HS or college. Same for probability and statistics.

The de-facto national semi-curriculum in Math for the past two decades has been the National Council of Teachers of Mathematics' (NCTM) Standards of 1989 & 2000. About 45 states, have adapted it. It marginalized arithmetic.

The NCTM and MD state Voluntary K-8 Math curriculum is *difficult* to teach and *difficult* to learn. It is *incoherent* and *each* year, has all these overarching topics: Arithmetic, Algebra, Geometry, Measurement, probability, Data analysis and problem solving. Soon after a topic is started, the teacher must switch to the next one -- *before* learning is moved into long-term memory. This makes it *easy* for students to forget a

Math topic within a month. Also, the Math curriculum emphasizes the wrong math, and it marginalizes the teaching of Arithmetic.

### **“Pretense of Arithmetic”**

Only about one in three (36%) of 738 education professors surveyed said that its “absolutely essential” to teach math facts and less than half (44%) surveyed said that its “absolutely essential” to teach phonics.

“a [Prince George’s County county] math coordinator [said] that county students should have a ‘sense’ of what  $9 \times 8$  is.” The implication being that students can use calculators to find that  $9 \times 8 = 72$ . The math coordinator said that not all students can memorize the multiplication tables, implying that since some cannot none should be required to do it.

“It’s time to confront those nagging doubts about continuing to teach our students computational algorithms for addition, subtraction, multiplication, and division [like  $23 \times 37$ ]. It’s time to acknowledge that teaching these skills to our students is not only unnecessary, but counterproductive and downright dangerous! .... It’s time to banish these vestiges of yesteryear from our schools and from our tests. ” Steve Leinwand, who was the math leader of the Connecticut state department of education. In 1999, he was co-chair of the US Department of Education’s Expert Panel on math textbooks.

#### **Student Test Scores – Fairfax County**

##### **IOWA Test Percentiles – Grade 8 Mathematics – Computation**

Year	Asian	Black	Hispanic	White	ALL
87-88	90	50	67	78	77
89-90	87	47	59	76	75
91-92	86	47	53	72	71
93-94	78	41	42	66	63
95-96	77	35	41	61	60
Change	<b>Down 13</b>	<b>Down 15</b>	<b>Down 26</b>	<b>Down 17</b>	<b>Down 17</b>

**UMCP STAT 100 Quiz problem.** Given:  $y = -36.9 + 5.07x$  and  $x = 20$ ; find  $y$ .  
A few students who forgot their calculators said they couldn't do this problem because they didn't have a calculator .

Just as fast as students and biology teachers can change 236 cents to \$2.36, they should be able to change 236 centimeters to 2.36 meters and 236 percent to 2.36.

To achieve this, the state standards for certification need to be raised. Note:  
"When a biology teacher had to teach (his chemistry students) how to change centimeters to meters, he just told them to move the decimal two places -- rather than illustrating the concept. ... 'Forty-five minutes later, only three of them got it.' "  
[(Howard County, MD) Washington Post, February 15, 1999]

### **“Pretense of Arithmetic Word Problems”**

NCTM and textbooks emphasize *wordy* "real world problems", usually with *little* math content, that is usually with *little* mathematical critical thinking .

**Problem.** (2000 sample MD HAS on Algebra) "The table below shows how a typical household spends money on utilities.

Utility Percentage of Total Utility Costs

Lighting	6	Refrigeration	9
Water heating	14	Appliances	27
Heating and cooling	44.		

A typical household spent \$1,400 on utilities last year. If there are no significant changes in their utility usage for this year, how much should they budget for heating and cooling their home this year?

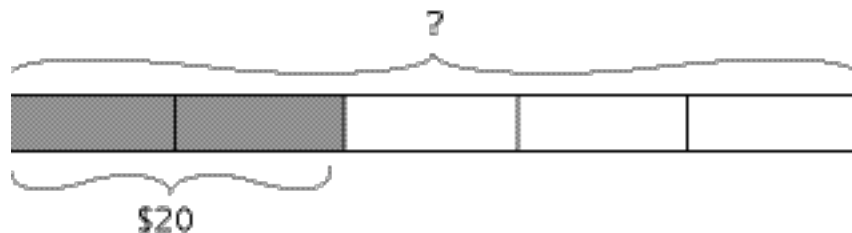
[Multiple Choice] F \$196 G \$378 H \$616 J \$784 "

This problem stymied more than 5 of 8 (65%) Grade 9 students, when it was field tested in Maryland.

**Problem 1.** [Singapore Math Grade 3a] Jamie picked 17 flowers and Lindsey picked 12. They gave away 20 of the flowers. How many flowers are left?

This type of "Two-step word problems" are not included in NCTM's "Curriculum Focal Points for Grades 1-5 (2006) and are minimized in textbooks.

**Problem 2.** [Singapore Math Grade 4a] David spent  $\frac{2}{5}$  of his money on a storybook. The storybook cost \$20. How much money did he have at first?



2 units = \$20

1 unit = \$\_\_\_\_\_

5 units = \$\_\_\_\_\_

He had \$\_\_\_\_\_ at first.

**Problem 17. (Singapore math Grade 5)** "Mrs. Chen made some tarts. She sold  $\frac{3}{5}$  of them in the morning and  $\frac{1}{4}$  of the remainder in the afternoon. If she sold 200 more tarts in the morning than in the afternoon, how many tarts did she make?"

([http://www.cbmsweb.org/NationalSummit/Plenary\\_Speakers/ma.htm](http://www.cbmsweb.org/NationalSummit/Plenary_Speakers/ma.htm))

**Problem** [NAEP Grade 8 2005]: There were 90 employees in a company last year. This year the number of employees increased by 10 percent. How many employees are in the company this year?

A) 9    B) 81    C) 91    D) 99    E) 100

Nationally, just 37% of Grade 8 students got the correct answer (This may include 15% who were lucky guessers.) Students who cannot do this problem will be at-risk in a rigorous high school chemistry course.

**A mid-level SAT Problem.** "How many minutes are required for a car to go 10 miles at a constant speed of 60 miles per hour?"

Students who cannot do this problem will be at-risk in a rigorous high school physics course.

These types of "Two operation" word problems fall thru the Math curriculum cracks; many students do not receive instruction on how to do them in Grades K-12.

### **"Pretense of Algebra"**

Symbolic manipulation is omitted from MD state HSA (exam) on "Pretend Algebra" Knowing  $2x + 3x = 5x$  not required.

**Suggestion:** kids can graph a simple line without a graphing calculator before they graduate from high school.

The head of math instruction for the state disagreed. "The technology is there. It's not going to go away," she said. "There is a limited population who can do math symbolically, the way mathematicians do. If this is an exam for all students, we want to make it comfortable for however students learn."

["With 'Pretend' Testing, a Poor Imitation of Preparing Students", Washington Post]

**UMCP STAT 100 Quiz:** Students were given a data set of five ordered pairs and asked to calculate the least squares regression line. Most all obtained the [correct] equation  $y = .52 + .7x$ , but over half of my class missed points because they did not correctly graph the line. ... even though most all plotted the ordered pairs, the line they drew on the graph was not  $y = .52 + .7x$ , but some arbitrary line.

Student comment: "Well, I graphed it on my calculator, shouldn't I get credit for that?"  
".... the calculator doesn't show the scale so I don't know how to do that."

Prospective high school math teachers use graphing calculators on Praxis II teacher licensing exam, so they are *not* required to be able to graph  $y = x$  *by hand*.

**"State and county math standards hurt student performance"** a student newspaper (2003). "[Montgomery County Public Schools] mandated changes to the Algebra I curriculum to align the course with the tested material [MD's Algebra Exam]. 'We don't think the material is what they need to know to be successful [in Algebra II and Precalculus],' said Blair H.S. algebra lead teacher Maria Costello".

"Changes in the curriculum are cited as a main cause for students' deficiencies in basic algebra, which are manifesting themselves in higher level math courses that require an

understanding of concepts taught in Algebra I. 'Our Algebra II students are worse than ever. Our Pre-Calculus students are worse than ever. It's falling apart as we go up the ladder,' said Costello."

**Decline in Percent of freshmen entering colleges in Maryland, who know Arithmetic and real high school Algebra I.**

	<u>1998</u>	<u>2005</u>	<u>2006</u>
Whites	67%	60%	58%
African-Americans	44%	33%	36%
Asian-Americans	79%	74%	76%
Hispanics	56%	42%	43%

**What could have caused these drops?**

- Teachers got worse? Not likely.
- Less funding for school? (Maybe funding went up then?)
- Change in demographics?
- Change in curriculum?

**“Pretentious” Data Analysis.**

Data analysis is often too tricky for high school and too tricky for the writers of the MD HSA on [Some concepts from] Functions, Algebra, Probability and Data Analysis. Let’s look at 2007 Public Release Algebra/Data Analysis Item #38 at [http://mdk12.org/assessments/high\\_school/look\\_like/2007/algebra/ftri38.html](http://mdk12.org/assessments/high_school/look_like/2007/algebra/ftri38.html)

This is also Item #37 at [www.mdk12.org/assessments/high\\_school/look\\_like/2007/algebra/hsaAlgebra.pdf](http://www.mdk12.org/assessments/high_school/look_like/2007/algebra/hsaAlgebra.pdf)

“In a small town, 250 randomly sampled registered voters were asked to state whether they would vote “Yes” or “No” on Measure A in the next local election. The table below shows the results of the survey.

**VOTER SURVEY RESULTS**

<b>Yes</b>	<b>No</b>	<b>Undecided</b>
96	34	120

There are 5,500 people expected to vote in the next election. Based on the data, how many people will vote “No” on Measure A in the next election?”

To obtain the correct answer, 2,112, students are expected to make the following unwarranted and usually incorrect assumptions:

The number of people, who will actually vote in the next election, is exactly (not just approximately) equal to the number expected to vote.  
None of the undecided people will make up their mind and later choose to vote "No".  
The fraction of people who will vote "No" in the next election is exactly (not just approximately) the same as the fraction of people who voted "No" in the survey.

The writers of the state math exams appear to have had little or no training in how to write Math precisely, without ambiguity and without loopholes. Writing Math correctly shares these attributes with writing law correctly.

Again, Data analysis is often too tricky for high school: UMCP Physics Professor, Tom Cohen's, observations of his child (a student in Montgomery County Public Schools) doing her HSA "Algebra" homework on "best fit" lines: "... the use of linear regressions (done by a calculator) to fit lines is not appropriate for algebra one students, ... . The students are NOT taught what a "best fit" line means mathematically, how to judge whether the model fits the data well ... nor even given any clear way to understand whether the data ought to fit a line. If you ask the calculator for a line which will fit points which lie on a parabola the calculator will spit back a line and the students will dutifully write it down. The issues are subtle and algebra one students are not prepared to deal with them. Thus, the students are being miseducated in data analysis and statistics."

"In my view this treatment is worse than useless, it is positively destructive. Students are told in essence to plug things in which they don't understand and then to trust the answers ... "

### **Pretense of taking "calculus" while in high school.**

Perhaps, one in four students, who studied "calculus" in high school, enrolled in second year calculus as college freshmen in 2010. Good for them.

Of the high school students who graduated in 1992 and studied "calculus" while in high school, about one in three took precalculus in college, and a further one in three took no calculus in college.

Of the high school students who graduated in 2004 and studied "calculus" while in high school, 17% took remedial mathematics in college.

This and lots of other interesting info & data:

"Issues of the Transition to College Mathematics"

MAA Retiring Presidential Address

[www.macalester.edu/~bressoud/talks/2011/JMM-transition4pdf.pdf](http://www.macalester.edu/~bressoud/talks/2011/JMM-transition4pdf.pdf)

Including

"There were **1,089** Bachelors in Math or Stat earned by African-Americans in 1997. By 2008, that number was down to **818**."

**Another view:**

NCTM President article: "**Endless Algebra—the Deadly Pathway** from High School Mathematics to College Mathematics" (2011)

(On NCTM website, Google: Algebra Deadly)