

Major Problems with the Core Mathematics Standards

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I. Introduction

Very recently I got a note from a highly skilled and aware Kindergarten teacher.

“Today the Pre-K and K teachers met with our AP. We were told that in order to be a highly effective teacher we must differentiate instruction, use cultural cues to hone in on each learner. We must know what is age appropriate, how kids learn, and IT’S NOT BY MEMORIZATION.

After the meeting the new teacher told me she needs to go home and cry.

I took it all in stride knowing now that no one really wants the kids to be too advanced.”

Sadly, I fully agree with her, especially her last sentence. Forces within the U.S. schools of education and our public schools are so focused on “leveling the playing field” that they seem to believe there is no room for the highly gifted, the artistically brilliant, and other academically talented children in our schools.

Today, the main driver for moving the schools further in this direction is the Common Core School Standards (CCSSI).

These standards have been sold to the country as the means to solve our Science, Technology, Engineering, and Mathematics (STEM) pipeline problems. But a detailed analysis shows that nothing could be further from their actual intent. If anything, they threaten to cut the STEM pipeline to a mere trickle.

In the remainder of this article we will focus on the CCSSI mathematics standards (CCMS), since mathematics is my area of expertise. The stated goal of CCSSI and CCMS in particular is given as describing the minimal academic expectations needed to equip *high school graduates with sufficient mathematical knowledge to enter the workforce as well as our colleges and universities with a reasonable expectation for success.*

To achieve this, the writers had to have a working definition of “college ready.” Jason Zimba, one of the three lead writers of CCMS, discussed their definition in testimony before the Massachusetts State Board of Elementary and Secondary Education on March 23rd, 2010. The definition turned out to be unexpected. Zimba gave it as follows: *“The minimal college ready student is a student who passed Algebra II.”* and the CCMS writing team wrote the standards to only reflect this minimal level.

The federal government was, presumably, entirely unaware of the definition above, because, whatever its implications, one of them could not be *improving the STEM pipeline*. But the government was so enamored with the stated objectives of college and workforce readiness, and above all improving the STEM pipeline, that it provided over 4 BILLION dollars through the Race to the Top (RttT) competition in order to induce the states to buy into CCSSI, and at least 45 committed to them.

One of the main things that I want to do in my testimony today is to analyze the consequences of this definition of college readiness. I hope that you will find them as disturbing as I do.

II. California: 1992

In California, standards that were very similar in to the Common Core Mathematics Standards (CCMS) were introduced in 1992 and the rhetoric that I've been hearing in support of CCMS is virtually identical to what we were hearing back then. For example, one of the key tenets of the California Standards was "there are no wrong answers to mathematics problems," and they gave certain standard examples "to demonstrate this."

The 20 percent of California families with the lowest annual earnings pay an average of 14.1 percent in state and local taxes, and the middle 20 percent pay only 8.8 percent.

What does that difference mean? Do you think it is fair? What additional questions do you have?

(What does "fair" mean here? We cannot have a mathematics problem unless every term is assigned a precise meaning!)

Recently, an East Coast parent sent me the following problem taken from a worksheet that her fourth grader brought home on one of his *new Common Core worksheets*:

Crates	Boxes	Bundles	Envelopes	Packets	Loose
2	35	?	?	?	?

Explain it! If you have 2 crates and 35 boxes,
how many bookmarks do you have altogether?

Explain your thinking.

Note the same issue here. There is no meaning assigned to any of the terms. So the "answer" can be anything you want it to be because this is not a problem in mathematics (her son's answer, 550,000, was marked "excellent" by the teacher).

Returning to California, programs like TERC's Investigations in Number, Data and Space, Mathland, Connected Mathematics (CMP), CPM, IMP, and CorePlus were written to align with the 1992 standards and were quickly adopted by virtually every district in the state.

They were heavily hyped and widely adopted due both

1. to their claims to focus on problem solving and other crucial "21st century skills."
2. and to the claim that they were mandated by the 1992 California Mathematics Standards.

Within a few years parents were screaming and the remediation rate for the top 30% of our high school students when they entered the State University System had jumped from 39% in 1992 to 54% by 1996 (and continued to climb for 4 more years to a high of almost 57%). The end result was the so called Math Wars, where parents forced the state legislature to have new standards created and the programs I listed disqualified for use in our schools. By 2005, the remediation rate was 37% and it was 31% in 2012.

Today, the programs I listed above are back, essentially unchanged from the 1990's versions, and are being advertised (now nationally) as aligned with CCMS. Moreover, they are being hyped using exactly the same language and claims as in California 20 years ago.

So I've taken to introducing my lectures on Core Standards by saying "Welcome to 1992 California."

III. CCMS's fix for the remediation rate problem

The CCMS go even further than the 1992 California Standards, and states applying for Race to the Top funds are expected to modify the requirements for college admission.

1. Moreover, the intent is that "passing Algebra II" is measured by passing a single test created by one of two consortia, PARCC or SBAC, both entirely controlled by our schools of education.
2. Any state that participated in the Race to the Top competition had to sign an agreement that all the public state universities and colleges would have to agree to allow students who had passed the Algebra II exam to take a *for credit* mathematics course (thereby ending the remediation problem!).

In effect, Core Standards cedes control of the entry level courses in our colleges and universities to K-12 and our schools of education. Bad idea!

IV. Core Math Standards, STEM, and Race to the Top

The CCMS were sold to the states by focusing on STEM and the project's leaders assured everyone that they would dramatically improve the STEM pipeline and STEM outcomes. The White-house web site indicates the importance the administration gives to improving the STEM pipeline.^[1]

The President's Council of Advisors on Science and Technology reported as their first recommendation in September, 2010:

The Federal Government should vigorously support the state-led effort to develop common standards in STEM subjects, by providing financial and technical support to states for

- (i) rigorous, high-quality professional development aligned with shared standards, and
- (ii) the development, evaluation, administration, and ongoing improvement of assessments aligned to those standards.^[2]

The stick the Obama administration used to encourage the states to adopt CCMS was the RttT initiative that required states to sign on to the Common Core Standards as a condition for obtaining an RttT grant. It is notable that the Request for Proposals (RFP) for RttT was published in the National Register in April, 2010, well **BEFORE** the final version of CCMS was even finished. See the comments on RttT on the White house web site.^[3] Also, see the RFP for RttT.^[4]

[1] www.whitehouse.gov/issues/education/reform

[2] www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-execsum.pdf, page 6

[3] <http://www.whitehouse.gov/issues/education/k-12/race-to-the-top>

[4] National Register, April 9, 2010, pps. 18172 - 18176, See page 18172, first column, first full paragraph

V. Who are CCMS for?

Jason Zimba, one of the three lead writers for CCMS clarified this question on March 23, 2010 in testimony before the Massachusetts State Board of Elementary and Secondary Education. During his prepared testimony he gave the following verbatim definition:

“We have agreement to the extent that its a fuzzy definition, that the minimally college-ready student is a student who passed Algebra II.”

Sandy Stotsky asked him to clarify his definition in the question period that followed and here is the verbatim transcript of that exchange:

Zimba clarified his definition as follows: *“In my original remarks, I didn’t make that point strongly enough or signal the agreement that we have on this – the definition of college readiness. I think it’s a fair critique that it’s a minimal definition of college readiness.”*

Stotsky remarked at this point *“for some colleges,”* and Zimba responded by stating:

“Well, for the colleges most kids go to, but not for the colleges most parents aspire to.”

Stotsky then asked *“Not for STEM? Not for international competitiveness?”* Zimba responded

“Not only not for STEM, its also not for selective colleges. For example, for UC Berkeley, whether you are going to be an engineer or not, you’d better have pre-calculus to get into UC Berkeley.”

Stotsky then pointed out: *“Right, but we have to think of the engineering colleges and the scientific pathway.”* Zimba responded

“That’s true, I think the third pathway goes a lot towards that. But your issue is broader than that.”^[5]

Stotsky agreed saying *“I’m not just thinking about selective colleges. There’s a much broader question here.”*

Zimba then added *“That’s right. It’s both, I think, in the sense of being clear about what this college readiness does and doesn’t get you, and that’s the big subject.”*

Stotsky then summarized her objections to this minimalist definition by explaining that a set of standards labeled as making students college-ready when the readiness level applies only to a certain type of college and to a low level of mathematical expertise wouldn’t command much international respect in areas like technology, economics, and business.

Zimba appeared to agree as he then said *“OK. Thank you.”*

[5] See Appendix A of the version of the Common Core Mathematics Standards posted in the late summer of 2010, after the release of the final version on June 2, 2010. There is a third pathway, and it is the “calculus pathway.” But since this so called pathway only uses mathematics standards that were already in the Core Mathematics Standards and, as Zimba pointed out in 2010, these standards are insufficient for reaching pre-calculus in high school, what was gained by listing them again? It seems safe to say that this “third pathway” does not actually exist. (For more details see the §XI of this paper)

VI. Special Things to Note in the Stotsky-Zimba Discussion Above

First, as mentioned in [5], the “third pathway” that Zimba was depending on does not exist in the final version of CCMS.

Second, Take Special note of Zimba’s clarification that “College readiness is NOT FOR STEM, and not for selective colleges.”

Third. It is very important that we understand that in CCSM, college readiness is only for “the colleges most kids attend, but not for the colleges most parents aspire to.”

In the next section we will see that the actual focus of “college readiness” is not four year colleges and universities, but instead, community colleges.

VII. The Meaning of the Core Standards Definition of College Readiness for Students

What does Common Core mean when it says that by addressing its standards “[students] will graduate from high school able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs?”^[6] In the context of Zimba’s remarks above we have to answer this question as follows: **college readiness appears to mean that students will (likely) not have to take a remedial course in mathematics or English if they seek to attend a non-selective or community college.**

This remarkable conclusion is further supported by a report from the National Center on Education and the Economy (NCEE), *Statement on Competencies in Mathematics Expected of Entering College Students*^[7] Note that NCEE was intimately involved in the development of CCMS. One of the three lead authors, Phil Daro, has been closely affiliated with NCEE for many years, and was the co-chair of the mathematics committee for the NCEE report.^[8] The report, [7], was originally released in April, 2010 – during the period CCMS was being actively designed and written – and was revised in May, 2013. It almost certainly explains why the original draft of CCMS only contained standards through most of Algebra I and less than half of Algebra II.

The report lends credence to Zimba’s 2010 definition of college readiness, and actually implies that the intended definition is *readiness for entry into a community college*, and not a “non-selective college or university.” Indeed, the report only focuses on community colleges, justifying this restriction by explaining that 45% of our students attend these schools. It also asserts that all the mathematics that is really needed for success at a (community) college is Algebra I.

See pps. 13-16 of the report for details of what NCEE means by essential mathematics expectations for STEM.

But be this as it may, CCMS are today taken to be the total requirements for entry into the workforce or **ANY** state university. This includes flagship schools like U.C. Berkeley, UCLA, , University of Michigan, and SUNY Stony Brook in NY. As was noted by Zimba, all of these schools, before Core Standards, required much more than just Algebra II for admission. But the details in [4], discussed in section IV, severely weaken these requirements.

[6] www.corestandards.org/about-the-standards

[7] (2013), <http://icas-ca.org/Websites/icasca/images/ICAS-Statement-Math-Competencies-2013.pdf>.

[8] www.toolkitforchange.org/toolkit/view.php?obj=1026

VIII. Summary of the Discussion Above

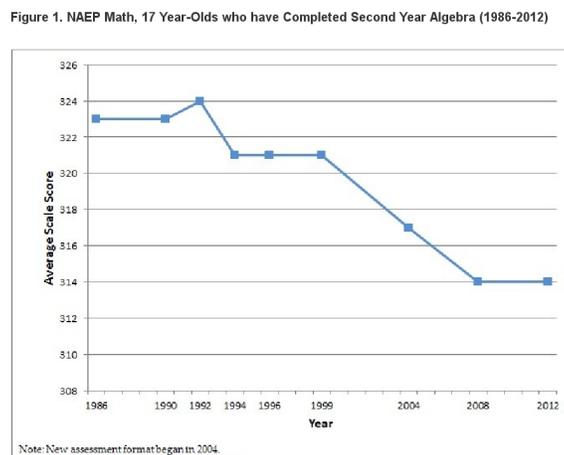
The discussion above suggests that Zimba’s statements at the March 2010 meeting of the Massachusetts State Board of Elementary and Secondary Education tell people very clearly what Core Mathematics Standards are really about when he expands on the stated object of these standards “preparing students for entry into the work force and college readiness.”

The discussion there can be summarized as saying that Core Standards are not for the top 30% of high school students, but instead for the truly “average” ones. So the main question is what will happen with the academically talented students. The expectation is that *they will regress towards the mean*, and we will lose a significant portion of them to mediocrity.^[9]

IX. What does CCMS’ Definition of College Readiness Say About the Schools

Given the expectation in CCMS that Algebra II is more than sufficient for students to have the mathematics they will need to succeed in this country’s IHE’s, the most likely thing to happen is for more and more students to be encouraged to take Algebra II in our high schools.

Actually, high schools have already been steering a greater and greater percentage of students into Algebra II for at least the last 15 years. Recently, Tom Loveless of the Brookings Institute studied the nations outcomes in Algebra II.^[10] Here is his key data. First he gives us the (long term) NAEP math scores for 17 year olds who had completed Algebra II:



Then he gives us the percentages of students for the years 1986 - 2012 who completed

[9] A zip file containing two MP4 files taken from the video of the March 2010 meeting and that include the material quoted above from Zimba’s testimony are available on the author’s FTP site. The URL is <ftp://math.stanford.edu/pub/papers/milgram/mp4FilesForIndianaPresentation.zip>

[10] Tom Loveless, *The Algebra Imperative: Assessing Algebra in a National and International Context*, Brookings Institute, Sept. 4, 2013

Algebra II:

Table 1. Percentage of 17 Year-Olds who Completed Second Year Algebra (1986-2012)

Year	All Students	White	Black	Hispanic
2012	76	79	69	69
2008	71	73	65	64
2004	69	69	66	62
1999	64	67	57	43
1996	63	66	52	49
1994	58	61	52	43
1992	54	57	45	37
1990	51	53	46	36
1986	44	47	32	30

As Loveless' data shows, the significance of Algebra II as a measure of college readiness has already declined. For example, in the next section we will see that in 1982, over 46% percent of the students whose last successfully completed high school math course was Algebra II obtained 4 year college degrees, but by 1992, it was only 39%. We would expect that with the full adoption of CCMS, this percentage is likely to decline considerably further.

In any case, few people and virtually no parents would accept a 39% or less likelihood of completing a 4 year college degree as "college ready." This will also force our colleges and universities to significantly lower the content of their credit bearing entry level math courses. In turn, this will have profound effects on the preparedness of these students for STEM and many other majors.

X. What does the Data Show about College Readiness?

There are a number of publications that the National Center for Education Statistics (NCES), the data collection and disseminating agency of the US Department of Education, has published over the last 15 or so years. A number of them shed light on the likelihood of degree attainment for high school students as a function of the highest math course successfully completed in high school. Moreover, the studies are consistent in showing that this datum is the strongest indication of the level of success in college, stronger than socio-economic status, GPA, or any other traditional measure.

C. Adelman at the National Center for Education Statistics in the U.S. Department of education^[11] analyzed the odds of obtaining a 4 year college degree against the highest math course taken in high school. He shows that a student whose highest successful math course was Algebra I was only 7% for the class of 1992, though it was 13% for the class of 1982. And if the highest successful course was Algebra II, it is better but was only 39.3% for the class of 1992 and 46% for the class of 1982. However, for each course above algebra II it is at least 60%, a huge difference. This shows the *crucial importance of students*

[11] Table 5 in The Toolbox Revisited: Paths to Degree Completion from High School through College, C. Adelman, U.S. Dept. of Education, 2006

having the resources to take courses **above algebra II** for STEM any any other area where at least a Bachelor's degree is required. Here are the key tables.

Table 5. Bachelor's degree attainment rate by highest level of mathematics reached in high school by 1982 and 1992 12th-graders

Level of math	Class of 1982		Class of 1992	
	Percentage reaching this level of math	Earned bachelor's	Percentage reaching this level of math	Earned bachelor's
Calculus	5.2 (0.36)	82.1 (2.45)	9.7 (0.54)	83.3 (2.72)
Precalculus	4.8 (0.37)	75.9 (2.43)	10.8 (0.65)	74.6 (2.04)
Trigonometry	9.3 (0.51)	64.7 (2.32)	12.1 (0.81)	60.0 (3.32)
Algebra 2	24.6 (0.75)	46.4 (1.54)	30.0 (1.08)	39.3 (2.31)
Geometry	16.3 (0.65)	31.0 (1.92)	14.2 (0.87)	16.7 (1.87)
Algebra 1	21.8 (0.69)	13.4 (1.33)	16.5 (0.92)	7.0 (1.24)
Pre-algebra	18.0 (0.66)	5.4 (1.19)	6.7 (0.53)	3.9 (1.34)

NOTES: Standard errors are in parentheses. The columns for level of math may not add to 100.0 percent due to rounding.

SOURCES: National Center for Education Statistics: High School & Beyond/Sophomore Cohort (NCES 2000-194) and NELS:88/2000 Postsecondary Transcript Files (NCES 2003-402 and Supplement).

Adelman also provides a table showing the distribution of high schools with these resources: [12]

Table 6. Percentage of 1992 12th-graders who attended high schools that offered courses* in statistics, trigonometry, and calculus, by race/ethnicity and socioeconomic status quintile

Demographic group	Percent attending high schools that offered:		
	Calculus	Trigonometry	Statistics
Race/ethnicity			
White	58.6 (1.67)	76.9 (1.29)	27.7 (1.62)
African-American	50.8 (4.14)	67.0 (3.90)	19.5 (2.71)
Latino	44.6 (4.04)	59.9 (3.55)	18.2 (2.44)
Asian	61.3 (4.31)	71.9 (3.61)	30.1 (3.94)
Socioeconomic status quintile			
Highest quintile	71.6 (1.93)	83.1 (1.64)	34.0 (2.30)
2nd quintile	56.2 (2.32)	73.2 (2.13)	27.1 (2.01)
3rd quintile	54.1 (2.39)	71.4 (2.33)	24.9 (1.92)
4th quintile	49.3 (2.46)	70.3 (2.28)	20.3 (1.80)
Lowest quintile	43.5 (2.86)	63.7 (2.66)	18.5 (2.06)

* Responses are based on surveys of school administrators and math teachers of NELS students in 1990. Where the administrator did not answer the question, the math teachers did not indicate that they taught the subject, and students did not earn any credits in the subject, the calculation assumes that the school did not offer the subject. This approach may underestimate the percentage of high school offering the subjects at issue.

NOTES: Standard errors are in parentheses.

SOURCES: National Center for Education Statistics: NELS:88/94 (NCES 96-130), and NELS:88/2000 Postsecondary Transcript Files (NCES 2003-402).

It is clear that the most important factor in determining whether these classes are available is socioeconomic status. Students attending high schools in the top 20% are 1.65 times more likely to be able to take calculus than students in the lowest 20%. Likewise, they are 1.3 times more likely to be able to take trigonometry.

What it means is that adopting Core Standards with the ancillary agreements and clauses in RttT will have the long term effect of *cutting down on the STEM pipeline* even more for students coming from less advantaged neighborhoods than is currently the case, since it is exactly the high schools in these neighborhoods that are most likely to drop courses above Algebra II if they are no longer required.

There is another area of concern here that needs to be mentioned. In California, and presumably in many other states, admission to the flagship state universities is limited to the top students in each high school's graduating class. In California, the top 8% -

[12] Ibid. Table 6.

10% are guaranteed admission to a university like U.C. Berkeley, in the University of California System, while the top 30% are guaranteed admission to a university in the State University System. In the U.C. system, pre-calculus is remedial, while in the State University System, Intermediate Algebra is remedial. With the likely loss of resources for more advanced courses in the high schools under Common Core, the top 30% will experience “regression to the mean” effects, and significantly fewer will be able to obtain 4 year college degrees.

XI. The STEM Pipeline

NCES also developed data on the likelihood of a STEM intending student obtaining a bachelor’s degree in a STEM area as a function of first math course taken in college. The data here is even more dramatic than the data in the section X.

National Center for Education Statistics

Table 7.
HIGHEST MATH COURSE IN FIRST YEAR: Percentage distribution of the highest level of mathematics in which 2003–04 beginning bachelor’s and associate’s degree students earned credits, by STEM entrance and persistence through 2009

STEM entrance and persistence through 2009	Beginning bachelor’s degree students				Beginning associate’s degree students			
	No math	Precollege-level math only ¹	Introductory college-level math ²	Calculus and advanced math	No math	Precollege-level math only ¹	Introductory college-level math ²	Calculus and advanced math
Total	40.1	8.7	30.1	21.2	49.2	24.5	22.9	3.4
Students who entered STEM fields in first year								
STEM leavers ³	34.3	9.3	24.0	32.4	44.2	21.2	28.4	6.2
Students who left PSE without a degree/certificate	39.9	12.1	20.2	27.8	50.5	16.2	28.0	5.3
Students who switched major to a non-STEM field	29.7	7.0	27.1	36.2	36.8	27.1	28.9	7.2
STEM persisters/completers	14.3	3.1	19.3	63.3	25.1	13.9	33.4	27.6
Students who completed a STEM degree/certificate	13.7	2.1	15.0	69.2	16.8	12.2	44.0	27.1
Students who entered STEM fields after first year								
STEM leavers ³	36.4	10.7	30.1	22.8	43.5	22.5	30.6	3.3
Students who left PSE without a degree/certificate	34.6	11.4	36.1	18.0	48.9	27.9	19.7	†
Students who switched major to a non-STEM field	37.6	10.3	26.4	25.7	35.8	14.9	46.3	†
STEM persisters/completers	27.1	5.4	20.0	47.6	37.5	17.8	27.4	17.3
Students who completed a STEM degree/certificate	24.2	4.3	17.4	54.1	18.5	12.6	37.0	31.9

See notes at end of table.

Only 2.1 percent of the STEM intending students who have to take a course below pre-calculus in college, and only 15% of such students who have to take pre-calculus as their first college math course ever obtain a STEM degree. On the other hand, nearly 70% of STEM intending students whose first college course is at least Calculus obtain degrees in STEM areas. The data shows that for the STEM pipeline, one has to regard pre-calculus as the minimal definition of “college readiness.”^[13]

This data had to be known to David Coleman, Mike Cohen, and Mark Tucker, the overall leaders of the Core Standards project. Yet they chose to ignore it, and effectively ignore the STEM pipeline, all the while touting CCMS to the federal government as well as the states as the best method for **improving STEM outcomes**.

XII. The Third Pathway

Zimba mentioned “the third pathway” in his March 23rd testimony, and in the March public draft of CCMS there were place markers for more advanced topics: These topics are consistent with Zimba’s comments. They are the major topics in a full one year calculus course.

[13] NCES, 2013, STEM in Postsecondary Education <http://nces.ed.gov/pubs2013/2013152.pdf>, page 23.

It would have been entirely routine for the writing team to include the material for the three missing courses that are needed for the STEM pathway: Calculus, Pre-calculus, and Trigonometry. But any hint of *any material more advanced than Algebra II* except for a very small number of trigonometry standards is completely absent in the final version of the CCMS. Indeed, **even the Calculus place-markers in the March draft are gone in the final version.**

The implication is that this was a decision made at the Core Standards project's leadership level.^[14] Moreover it is clear that the federal government bought a PIG IN A POKE when they funded and published the RFP for RttT, and the same can be said for the states when they signed on to the CCSSI, and then applied for RttT grants.

We cannot escape the conclusion that the real cost of this PIG will probably be huge – both in dollars and in the loss of crucial human capital.

XIII. A possible approach to fixing this for New Hampshire

In spite of the issues raised above, it is true, first that Core Standards are considerably better than the old New Hampshire Math Standards, and second, that much of the material in them is very well done. In fact Core Standards are better than the standards of 90% of the states, though the problems discussed above make them entirely unsuitable for state adoption.

What I would suggest is that New Hampshire put together a writing group composed of a few teachers with top level records of success, and some mathematicians from the math departments (not the education schools) in top New Hampshire universities such as Dartmouth. Then, using Core Standards as a model, create top level standards for New Hampshire. It is not that hard to do.

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[14] The exact identity of the leadership is unclear, but it seems to include David Coleman, Mike Cohen, Marc Tucker, and Linda Darling-Hammond.