

University Students' Opinions about the Mathematics that is Taught in Grades K-12

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1. A description of our study

Five hundred eight undergraduate students, some enrolled in mathematics courses for non-math majors, and others enrolled in a computer science class, answered an anonymous survey about what mathematics should be taught in grades K-12, and how it should be taught.

1.1 The survey

Now that you have completed your education in grades kindergarten through twelve, we would like to ask your opinions about the mathematics you studied. All your answers are confidential. Thank you.

During those thirteen years of schooling, which topics in mathematics should be obligatory for all students? Which topics should be available but not required? Which topics should be dropped?

Math topics that should be obligatory:

Math topics that should be available but not required:

Math topics that should be dropped

(Survey, continued)

Did the tests that you were given judge fairly your knowledge and skill in math?

always mostly sometimes never

Should technology (e.g., calculators, math software) be used in

Elementary grades	yes	no
Middle school	yes	no
High school	yes	no

Should students be required to memorize:

Addition facts	yes	no
Multiplication facts	yes	no
Selected algebraic formulas	yes	no

Any additional comments and explanations are appreciated.

The first four questions (What topics should be obligatory, available, dropped?) were asking for a general evaluation of the precollege math curriculum.

The last two were asking about two topics that are hotly debated among math educators: the use of technology and the role of memorization.

1.2 Participants

Subjects in College of Arts and Sciences

1. "Mathematics Appreciation"
(for liberal arts majors)
No. of students: 188 (2 large sections)
Prerequisite: High school algebra
2. "Intermediate Algebra"
No. of students: 101 (3 sections)
Prerequisite: none
3. "College Algebra"
No. of students: 20
Prerequisite: Intermediate algebra
4. "Calculus for Biological and Management Sciences"
No. of students: 69 (1 section)
Prerequisite: College algebra
5. "Statistical Applications"
No. of students: 30
Prerequisite: none
6. "Statistics for Engineers"
No. of students: 46 (2 sections)
Prerequisite: Calculus

462 subjects in Arts and Sciences

Subjects in College of Engineering

“Theory of algorithms” for Computer Science majors

No. of subjects: 46

Prerequisite: Two semesters of calculus

Total no. of subjects: $46 + 462 = 508$

2. Results and discussion

2.1. Opinions about topics in the K-12 curriculum

From the survey:

During [your] thirteen years of [K-12] schooling, which topics in mathematics should be obligatory for all students? Which topics should be available but not required? Which topics should be dropped?

Math topics that should be obligatory:

Math topics that should be available but not required:

Math topics that should be dropped:

We were not able to classify the answers to the above three questions because there was no agreement among students about what a math topic is.

Some examples of “math topics” listed by students:

quadratic formula

addition, subtraction

fractions, logarithms, derivatives

Algebra I, Algebra II, Pre-calculus

Basic math (four arithmetic operations)

Basic math (everything below calculus)

Math useful in everyday life, word problems

Everything else, everything but, ..., all, none

Also, some students would mix different meanings in their answers.

For example,

Required: Algebra, Geometry, Stats

Optional: Everything else

Dropped: Fractions

Many students simply wrote nothing, or wrote something that would indicate that they did not consider these questions meaningful.

For example,

Required: Fractions, logarithms

Optional: Addition, subtraction

Dropped: none

Summary:

It is possible that most students do not have a cohesive view of mathematics as a discipline, or as consisting of “topics”, and that they perceive it merely as a sequence of classroom activities; it is also possible that they did not consider the first three questions as meaningful or legitimate.

(Our subject pool consisted of non-math majors and was weighted heavily toward those with very little math background, which could help explain this finding.)

2.2 Fairness of the tests

From the survey:

Did the tests that you were given judge fairly your knowledge and skills in math?

	always	mostly	sometimes	never
A&S students	8%	52%	36%	3%
CS students	7%	72%	21%	0%

Overall, students are satisfied; they indicate that the tests “mostly” judge fairly their knowledge and skills. The CS students (with higher math knowledge) are more positive about this than A&S students.

2.3 Opinions about technology use and memorization

The last section of the survey asked:

Should technology (e.g., calculators, math software) be used in

Elementary grades	yes	no
Middle school	yes	no
High school	yes	no

Should students be required to memorize:

Addition facts	yes	no
Multiplication facts	yes	no
Selected algebraic formulas	yes	no

Use technology
in:

Elementary grades	no	no	no	yes	all other patterns
Middle school	no	no	yes	yes	
High school	no	yes	yes	yes	
No. of subjects	33	174	162	133	6
Percentage	7%	34%	32%	26%	1%

Summary

A large majority of students (92%) think that technology should be used in schools, but opinions about when it should start are divided. Only 26% think that it should start in elementary grades; 32% favor starting in middle school; and 34% think technology should be used only in high school.

Should
students
memorize:

Addition facts	yes	yes	no	no
Multiplication facts	yes	no	yes	no
No. of subjects	466	2	13	27
Percentage	92%	0%	3%	5%
Selected algebraic formulas	yes	no		
No. of subjects	362	146		
Percentage	71%	29%		

A large majority (92%) think that both addition and multiplication facts should be memorized. And 71% favor memorizing selected algebraic formulas.

We found the results about technology (7% say, don't use it at all in grades K-12; 26% say wait until high school; and 58% say wait until at least middle school), and about basic facts (92% said memorize both addition and multiplication facts) rather surprising. We think this is a somewhat conservative point of view, especially with the pervasive availability of technology in young peoples' lives.

Opinions about technology use and memorization of facts are heatedly discussed among math educators. We will look at this again when we compare students' opinions to the Common Core State Mathematics Standards.

We found only a small interaction between opinions about using technology and memorizing facts and formulas. (Percentages of the total are in the table.)

		Memorize addn & mult facts?		Memorize algebraic formulas?	
		yes	no	yes	no
How	none (33)	31 (94%)	2 (6%)	24 (73%)	9 (27%)
	much	163 (94%)	11 (6%)	122 (70%)	52 (30%)
	tech-	151 (93%)	11 (7%)	113 (70%)	49 (30%)
	nology?	All grades (133) (86%)	18 (14%)*	98 (74%)	35 (26%)
		Other ** (6) (100%)	0 0%	5 (83%)	1 (17%)

Their opinions about technology and memorization are mostly independent of one another.

Comparing answers of Computer Science (46) and Arts and Sciences (462) students

	Addn & mult facts should be memorized		Selected algebraic formulas should be memorized	
	CS	A&S	CS	A&S
No tech	11%	6%	7%	5%
Only HS	22%	33%	20%	24%
High & Mid	22%	30%	20%	22%
All grades	30%	22%	34%	18%
Other	2%	0	2%	1%
Total	87%	91%	83%	70%

CS students had stronger math backgrounds than A&S students, but the pattern of their answers is similar.

More CS students think that memorizing formulas is important (83% to 70%).

2.4 Students' opinions compared with the Common Core State Mathematics Standards (CCSMS)

The CCSMS were released by the National Governors' Association Center and the Council of Chief State School Officers in June 2010 and have been adopted by 46 states and the District of Columbia. They are being phased in and will be implemented across the nation by 2014. That is, it is planned that there will be a national curriculum based on them.

The 93-page document is available online at http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

We examined the document to see how it treated memorizing basic facts and formulas, and the use of technology.

The word “memorize” (or memory or memorization) appears exactly twice in the document:

“By the end of grade 2, know from memory addition facts of two one-digit numbers.” (p. 19)

By the end of grade 3, know from memory multiplication facts of two one-digit numbers.” (p. 23)

Is this “standard” in agreement with our students? 92% of them thought students should memorize both addition and multiplication facts.

The word “calculator” or “calculators” occurs five times in the CCSMS (pp. 6, 7, 7, 58, & 81), but only in describing high school mathematics, and there only in the context of spreadsheets, analyzing graphs, and changing the viewing window on a calculator to get needed information.

Software is mentioned 7 times (pp. 7, 53, 55, 73, 73, 76, 76); only once in 8th grade, in the context of understanding congruence and similarity, using dynamic geometry software; and similarly in high school.

This hardly mirrors what our subjects say:
26% support using technology in all grades,
32% in middle and high school,
34% only in high school, and
7% never.

Memorizing algebraic formulas

Not once is memorizing algebraic formulas mentioned in the CCSMS. Rather, they are to be “used” or “known”:

Grade 4: apply area and perimeter formulas

grades 5 & 6: apply... use... discuss..formulas

grade 7: know the formulas for the area and circumference of a circle

grade 8: know the formulas for the volumes of cones, cylinders, and spheres, and use them...

HS algebra: Use, Apply, Rearrange a formula (e.g. $A = \frac{1}{2}bh$; what does h equal?)

71% of our subjects say selected algebraic formulas should be memorized.

Our subjects seem to lean more toward technology use and toward memorizing basic facts and formulas than do the Common Core State Mathematics Standards.

2.5 Students' comments

From the survey:

Any additional comments and explanations are appreciated.

On teachers:

I think teachers should have to take tests to see what they are asking us to do.

On tests:

I think that standardized tests have taken over the curriculum in schools to the extent that students are becoming great test takers and have little or no knowledge beyond that.

Complaints:

I went to in ... I think the math program there is not worth anything.

Public school is a joke. They care more about their funding and not about educating future generations.

Today's generation of students is not prepared well enough for the future with their lack of math skills.

We need improvements in the way math is presented so that it is not boring and keeps students interested.

Every other country is more educated in math.

Basics:

The math required should be the basics and be applicable to the student's future career.

Math classes should only be mandatory if you need the math to do whatever it is you are studying to be.

Any math taught beyond the basics should be applicable to adult life and not made so dull.

Too much algebra for no good reason or application.

Technology: pro

Formulas can be found easily through computer searches.

Adults look things up.

Calculators are always going to be available in the working world especially moving forward in society with phones etc.

Everyone needs to learn to use a calculator.

Technology: con

Technology should be used in all grades, but not as a crutch, more of a way of reinforcing what has already been learned Tests should NOT involve calculators.

I can get an answer on a calculator, but I can't tell you why or what the answer really means.

I never used a calculator til I got to college, and I seem to be ahead, so keep it like that.

With technology available math can be plugged into a computer/calculator and given to you. (pro? or con?)

Difficulty:

Math is hard. It hurts my brain.

3. Conclusions

In K-12 education no one asks students what they think, what they want to learn, what they find worthwhile to study.

Compare this to the situation with health care providers. I as a patient have a say in the treatment I am given.

At the university level, my courses and yours are evaluated by our students, and we take these evaluations seriously. But this is not done in K-12 education. Students are not asked; they are told what they have to learn, regardless of whether they want to learn it or not.

We think that the decision about what should be in the math curriculum should be made by people who have graduated from high school, not just by mathematics educators and mathematicians.