

University Students' Opinions about the Mathematics They Studied in Grades K-12

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1. Introduction: Our survey

At present math education in grades K-12 is under close scrutiny from politicians on both the federal and the state level (Race to the Top, Governors' Common Core State Standards).

But many other groups of people, and individuals, are involved now and have been involved in the past in the development and modification of math curricula (NCTM, teachers' unions, MAA, AMS, parents' groups, individual mathematicians, and math educators, promoting different programs and pedagogical approaches, and social activists, concerned with equal access to education).

But there is one group we haven't heard from: K-12 students.

In all discussions about math education, students have not been treated as partners, but as subjects that have to be motivated, educated, tested, reeducated, retested, and finally, certified as proficient in mathematics.

To find out what students think about the mathematics that they have studied in school, we gave the following anonymous survey to undergraduate students taking college math classes:

Survey

We would like to know what you think about the mathematics you have taken in school (from the 1st to 12th grade).

What were your best and worst experiences, and why?

Which topics were worth learning and which were worthless, and why?

When you answer these questions, try to be specific about the grade, and if you remember, a textbook.

All your answers are confidential, so you may also talk about the teachers you had. Thank you. (If you need more space, continue on the back of the page.)

Best experiences:

(space for answer)

Worst experiences:

(space for answer)

Most valuable topics:

(space for answer)

Worthless topics:

(space for answer)

The questionnaire was brief and the questions were vague because we did not know what kind of answers to expect, or what aspects of their education students would consider relevant.

Students' answers to questions varied in format and amount of detail, and in their personal approaches to specific questions.

Examples

Brief: "Algebra 2, super easy" (Best experience)

Detailed: "I don't remember specific topics, but I had really great math teachers in elementary school. I was in a multiage class and the only time we split up was for math. It was a nice change, and I really excelled. I had an incredible geometry teacher my freshman year in school. She was tough but taught us a lot. My calc teacher, my senior year, had been teaching calc and physics for almost 50 years. We had him for AP in his last year before retirement. He made the class really fun and although I didn't pay very close attention (senioritis), I feel I took good things out of it." (Best experience)

Personal: "When you are dyslexic everything is your worst experience." (Worst experience)

Political: "Learning math in the USA" (Worst experience, foreign student)

Opinion: "Things we won't use in the real world" (Worthless topic)

Math buff: "None!" (Worthless topic)

2. Respondents

357 students taking five undergraduate classes at two universities participated.

- (1) 136 students from an introductory computer science course taught in three sections. The course had a strong math prerequisite, and students taking it had math backgrounds varying from strong to very strong. (CompSci)
- (2) 62 students taking business calculus, who had adequate mathematical backgrounds. (BusCalc)
- (3) 49 students from an intermediate algebra course, for students with a high school math background. (IntAlg)
- (4) 110 students from two different classes titled "Math Appreciation", offered to students who had no interest in math, but were required to take some math classes. (MathAppr)

In this study we were interested in finding concerns common to most students; we were not looking at differences, so we will not discuss differences among the four groups of students listed above.

3. Best and worst experiences

The main causal factor of both the best and the worse experience was the classroom teacher.

Teacher as a factor in:	best experience	worst experience
Group:		
1. CompSci	45/136 33%	32/136 24%
2. BusCalc	34/62 55%	28/62 45%
3. IntAlg	19/49 39%	22/49 45%
4. MathAppr	39/110 35%	42/110 38%
Total	137/357 38%	124/357 35%

Examples

"All my high school teachers were a real help and taught their classes well." BusCalc

"Geometry. But in all honesty it was the teacher who made the difference." MathAppr

"The teacher was retiring & made way too many mistakes." CompSci

"Algebra II was difficult because she gave us the homework assignment and gave few examples and had me confused the majority of the time." IntAlg

Understanding and not understanding were often listed as reasons why the experience was good or bad.

	Good experience Understanding	Bad experience Not understanding
1. CompSci	7/136 5%	9/136 6%
2. BusCalc	9/62 15%	12/62 19%
3. IntAlg	12/49 24%	14/49 29%
4. MathAppr	11/110 10%	15/110 14%
Total	39/357 11%	50/357 14%

Examples

"I had a blast in Algebra II! I understood everything!" CompSci

"Finally understanding material learned." IntAlg

"Not understanding what to do to figure out the problem." IntAlg

“Probably when I don't understand something I get super frustrated.” IntAlg

Only a few students mentioned grades or passing or failing a class in the context of their best or worst experiences.

	best experience	worst experience
1. CompSci	8/136 6%	5/136 4%
2. BusCalc	2/62 3%	4/62 6%
3. IntAlg	2/49 4%	3/49 6%
4. MathAppr	2/110 2%	5/110 5%
Total	14/357 4%	17/357 5%

Students who listed *none* or *all* of their experiences as best or worst:

	All best	No best	No worst	All worst
1. CompSci	3/136 2%	1/136 1%	5/136 4%	0/136 0%
2. BusCalc	1/62 2%	2/62 3%	3/62 5%	0/62 0%
3. IntAlg	0/49 0%	1/49 2%	2/49 4%	1/49 2%
4. MathAppr	1/110 1%	9/110 8%	2/110 2%	12/110 11%
Total	5/357 1%	13/357 4%	12/357 3%	13/357 4%

Remarks

Many students were very emotional in their descriptions of teachers. Some even used obscenities in describing teachers whom they did not like.

We expected that grades would be much more prominent in students' recalls of their experiences. But it seems that even when grades may be important at the time students take a class, they do not really matter.

The fact that for 4% percent of students, all of their experiences in math classes were uniformly bad, is really disturbing.

4. Most valuable and least valuable topics

The four (high school) topics that were most often listed as most or least valuable were: Algebra 115, Geometry 81, Calculus 75, and Trigonometry, 47.

No other topic was listed more than 20 times. (Many students listed more than one item in each category.)

	Most valuable	Worthless
Algebra	102/115 89%	13/115 11%
Geometry	36/81 44%	45/81 56% ←
Calculus	56/75 75%	19/75 25%
Trigonometry	35/47 74%	12/47 26%

The scores for geometry came as a surprise. They indicate that the way that geometry is currently taught needs to be seriously revised.

But most students would list something much more specific as worthless or as most valuable.

For example,

"Eigenvalues seemed pretty worthless."

"Ratios and long division. We have calculators and most of the time no one expects you to do it (by hand)."

And most valuable,

"Estimating. Coin counting. Everyday use mathematics."

"Addition and division."

But also there were students who thought that all (or almost all) mathematics is valuable, and students who thought that all (or almost all) mathematics is worthless.

	Most valuable All	Most valuable None	Worthless None	Worthless All
1. CompSci	7/136 5%	1/136 1%	30/136 22%	4/136 3%
2. BusCalc	1/62 1%	2/62 3%	5/62 8%	3/62 5%
3. IntAlg	7/49 14%	0/49 0%	7/49 14%	2/49 4%
4. MathAppr	2/110 2%	6/110 5%	5/110 5%	11/110 10%
Total	17/357 5%	9/357 3%	47/357 13%	20/357 6%

Some students stated that mathematics is worthless just for them.

Having bad experiences with math and thinking that math is worthless are correlated, but the causal relationship is far from being obvious.

No student mentioned "proofs" as most valuable, but some mentioned them as worthless:

Group 1 (CompSci)	10/136	7%
Groups 2, 3 and 4	8/221	4%
Total	18/357	5%

It is disturbing that the group with the best math background (CompSci) showed the least appreciation for the deductive aspect of mathematics.

Another example of a specific concept that was listed only as worthless was "imaginary numbers" (10 students).

Also 2 students listed "invisible numbers" as worthless, but we are not sure what they meant!

Most valuable topics

1. There was one dominant feature in listing the most valuable topic in mathematics. It was "basic mathematics". The word "basic" was used by 41/357 (11%) of students in describing the most valuable topics, and it was never used to describe a worthless topic. And the concepts actually referred to by some students as basic were those who were often listed by many other students. This view was clearly represented by the following statement about what is most valuable:

"How to use Mathematica. Theories behind math, and the general basics of how to solve problems, anything in depth is a waste of time."

But "basic" means different things to different students.

Many students considered algebra as basic "because it is used in many other types of math and science" or because "everything made sense after (it)".

Other students considered elementary math as basic.

"Addition, subtraction, multiplication, division, ... everything learned in elementary school."

"Math basics. Addition and subtraction in grade 1."

And for other students, "Derivatives and integrals" were the basics of calculus. For example, "Calculus: derivatives and integrals; algebra; simple math."

2. Another theme mentioned was "mathematics that is used in the real world".

Group	math in the real world
1. CompSci	12/136 9%
2. BusCalc	8/62 13%
3. IntAlg	4/49 8%
4. MathAppr	14/110 13%
Total	38/357 11%

But all statements about the value of math in the real world were general and didn't list any specific applications.

For example,

"Basic skills that help me with life"

"Algebra, because you use it in everyday life."

"Topics that can be applied in our everyday lives."

"Calculus (this relates to physics, and you begin to see how math relates to the world)."

5. Final comments and questions

The reason for making this survey was to find out what topics are relevant to students, so that we could start asking more specific questions related to their views of math education. So any conclusions derived so far are at best tentative.

Also, the sample of students was not only non-random (we do not think that it is possible to get a random sample from the population of school students), but is biased because it doesn't include high school students who didn't enter college, or who dropped out.

Answers concerning the best and worst experiences confirmed common knowledge about the crucial role of teachers.

But the fact that a small but significant percentage of students said that all their experiences with math were bad and that math is worthless for them indicates that the current "Race to the Top" tenet that achieving proficiency in all required math subjects should be a requirement for all students, could be "cruel and unusual punishment" for a small but significant minority of school children.

The picture that we can draw from the answers about the value of mathematics is rather vague and will require further investigation.

Students do not see math as a deductive system or as a collection of such systems (the concept of a proof is mentioned only as something "worthless".) But they see mathematics as something that needs to be understood.

Most students consider mathematics as valuable and related to the "real world", but they didn't provide any indication that they know how mathematics is actually used in modern society.

We were surprised that almost no students mentioned computer and calculator technology.

Many students have the idea that some part of mathematics is "basic". But their ideas what is basic are very diverse.

We think that a much broader and more detailed study of students' opinions about their education would be valuable. And that it should include questions such as,

Which topics should be obligatory for all students?

What topics form a "basic education"?

What role should grading and tests play in judging a student's successes and failures?

What aspects of current school systems should be changed?