THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release October 20, 1997

PRESS BRIEFING BY
SECRETARY OF EDUCATION RICHARD RILEY

The Briefing Room

1:12 P.M. EDT

SECRETARY RILEY: Thank you so much. I just have returned from traveling with the President to Brazil, and some of you were there, and I'm here today to release a major report and also to brief you on the week ahead -- this is a very important week, as you know for education -- on the President's education agenda.

The President, as you know, used his Saturday morning radio address to praise a bipartisan effort to support charter school legislation that is now moving through the Congress. He also used the radio address to endorse another bipartisan legislative initiative that is being led by Congressman John Porter and Congressman David Obie to fixing failing schools. We know how to fix failing schools, and the Porter-Obie initiative is targeted funding to help get that job done.

Now, today we're releasing a major report entitled, "Mathematics Equal Opportunity." That conveys three powerful messages: first, that young people who go on to college, by overwhelming numbers -- 83 percent -- take the serious math courses like algebra I and geometry. Second, that taking these gate-keeping courses is especially important for low-income students. Seventy-one percent of low-income students who took algebra I and geometry went on to college, compared to 27 percent of low-income students who did not take these courses.

Now, I just met with a group of young people from Prince George's County who were part of the College Board-sponsored Equity 2000 Initiative to get more young people to take algebra early. These young people have gotten the message that getting ready for college is their responsibility, and that means taking the serious math courses.

But we need to make sure that everyone gets this message. Only 63 percent of all young people take algebra and geometry, and only 43 percent of low-income students take these math courses. And that's precisely why the President has called for voluntary national tests in 4th grade reading and 8th grade math. I assure you that these tests will shake up the status quo and will

make things happen.

The third message of this report is that taking the right courses is more important than what type of school you attend, whether it's public or private. The latter point, I think, deserves some attention. Many voucher proponents argue that giving parents public tax dollars to send their children to private school is the key to educational renewal.

This report says there is a much more important choice that's being overlooked entirely, and that is the choice of courses. That is a choice, also, and a very important one. Taking the right courses matters a lot more in terms of going to college than whether your school is private, public, or parochial. There are very good

schools in all categories, as we know, all across the country and mediocre schools and others that need a lot of help. But the type school that a child attends turns out under these numbers not to be as significant in terms of going to college as to the choice of courses they take.

Now, let me go on and tell you a little bit about the rest of the week, then I will respond to questions. Tomorrow, the President will meet with college and university leaders who have endorsed his America Reads challenge. We have thousands of energetic college students signed up to be reading tutors and ready to go, and we're excited about that.

We also want the Congress to act on the President's request for legislation. I'm concerned that the House is starting to get stuck in the usual partisan rut and losing sight of what is really important in education. I think it's a sad day when a reading initiative, a reading initiative, becomes a political pawn because some members of Congress do not support the President's call for voluntary national tests in reading and math.

Now, making sure that all of our young people are literate is a grand goal that has full support of the American people. Congress needs to fulfill its part of the bargain. Let's remember that the reading initiative was part of the budget agreement. And for his part, Vice President Gore, then, will be visiting Louisiana State University and give a major address on race and education at Southern University Law Center.

And on Wednesday, I will join Larry Summers, who is the Deputy Secretary of the Treasury, at a press conference with Representative Charlie Rangel to once again reaffirm the administration's strong opposition to the Coverdell IRA-education proposal. The Coverdell proposal is bad tax policy. It is outside the balanced budget framework, and it has little if anything to do with improving public education.

On Thursday, the President, the Vice President, the

First Lady and several members of the Cabinet, including Donna Shalala and myself, will participate in the White House Child Care Conference. Then on Friday, both the President and the Vice President will once again focus on education. The President will meet with several hundred teachers who are part of the effort surrounding the National Board for Professional Teaching Standards. The President's goal, as you've heard, is to have 100,000 board-certified teachers in the next 10 years.

For his part, Vice President Gore will announce a new public-private partnership to match computers donated from federal agencies to low-income schools. Now, this is a very busy week for the administration when it comes to education, and that's the way it should be. Education is President Clinton's number one priority, and we need to pick up the pace in order to get all of America's children ready for the 21st century.

Education matters to parents all over America, and the President is determined to get things done. The President's education agenda is comprehensive and it gets to the heart of the issues that need to be resolved to improve American education -- things like higher standards, better-trained teachers, safe schools, computers in the classroom, more accountability, more public school choices, and an absolute commitment to making sure that all of our children -- all of our children -- have mastered the basics once and for all.

My biggest concern is that the Congress is fiddling at the margins and not focusing on these essential and central issues that define American education. The President wants some action and I think that the American people want to see some movement as well. The administration is prepared to work with the Congress in a bipartisan way, but we do need to get on with the business of improving American education.

Now I will be happy to respond to any questions.

Q Secretary Riley, is the President still committed to vetoing the D.C. appropriations bill if there are these vouchers included in there?

SECRETARY RILEY: And we just got back from South America, you and I, and I'm not positive if there's been any statement in the last day or so. As I recall, certainly senior staff has indicated that they would recommend that the President veto that if that measure is in there, and I think that's where the status is right now.

Q Could you explain in your own words, obviously, why poor children in the District of Columbia would be denied the opportunity to go to a better private parochial school or to go to a suburban school, that the President would take this opportunity away from 2,000 poor kids in the District of Columbia?

SECRETARY RILEY: Well, I would be glad to. First of all, we're into trying to help solve problems, to build better

schools, to help states and school districts and schools get better. The idea of giving someone a ticket out of the school solves no problems whatsoever. It is a non-solution to major problems. We know what to do to improve schools. We could take that same $7 million that they propose to come in and pay for vouchers for 2,000 children and impact in a very significant way probably as many as 40,000 children. Having school reform measures like the Slavins program and Comers program and others, and new American schools, all of those efforts that are there waiting to come in -- we're doing that, by the way, in a number of elementary schools here in Washington, D.C., and I think we're seeing some real positive results.

So what do you do? You pull 2,000 kids off, and who decides who it's going to be and where they're going to go? They'll be going to some -- perhaps many of them -- to a parochial school, a religious school. So the answer that they have in there is some governmental body appointed by the House and Senate and the President comes in and says this religious school is all right, this one isn't. Or do they say all of them are all right? Or who is to judge? Once you get into that judging process, you have made them public. That doesn't help private and parochial education. I strongly support quality private and parochial schools. But the idea of siphoning people off to an unidentified place chosen by public officials to me distorts the great mix we have now with public, private and parochial. Now, the idea of improving the schools in Washington, D.C. is very important, and all of us ought to be into it, especially those of us in the federal government. And we are, ourselves, into it and we are prepared to get as much into it as the Congress would enable us to.

We think that we could really make a big difference, and that is, as I say, beginning to happen. But vouchers would in no way solve any of the problems in the Washington schools.

Q Mr. Secretary, why is it okay for the President to threaten to veto the education appropriations bill, but it's outrageous, in your view, for Congressman Goodling to threaten the America Reads program over the national standards and tests policy dispute with the administration?

SECRETARY RILEY: Well, you know, you have a reading proposal that I think everyone is ready to get busy on. We have these college students that are ready, we've got grandparents and senior citizens, we've got teenagers -- everybody is excited about the reading program. And to say that somehow it's going to help education by holding that up or holding it hostage because the President wants to have a voluntary testing program tied to NAEP -- NAEP is in all 50 states now, it's a sample test. We're simply saying to make the sample test individual so a parent can see how well their child is doing in very basic skills -- not in controversial subjects; we're talking about reading in the 4th grade and math in the 8th grade with algebra, just like this study says is so important.

So we think that's a very clear, clear issue and to tie

then the reading measure to that is certainly not any way in the world to interpret that as being helpful to education. Then, when you look at vouchers, in my judgment, vouchers are harmful to public education. I think they've harmful to private and parochial education, too, as I've just said. You need -- something that you think is harmful to public education I think you should veto, and that's what I would advise the President to do.

Q Secretary Riley, in terms of the economics of a family budget, if vouchers were to go through as they've been proposed in various forms, could they ever provide a school opportunity to a very poor family that would need to use only the voucher to finance the education of their child, or would vouchers even, under the best of circumstances, only be a subsidy to families that are already better off?

SECRETARY RILEY: Well, I think that's a very good question and, of course, the answer would be mixed. Some families would be totally dependent on the voucher, they would have certain serious limitations of choices then as to what the voucher would afford. Others who could afford private school can make a very good argument that if you're going to give the person sitting next to me a voucher, then I'm entitled to one, too -- that person might be poor, also.

So, I mean, you start getting into this very mixed up and confusing interrelationship; you're mixing up public and private, and religion. It's clear to me that if you are a very poor person and you are uneducated, and you are subject to entrepreneurs and you have a voucher for $3,200, that, too, worries me as to who could convince you to come to their school, or whatever. I think the whole scheme is just replete with problems and, as I say, I think it is harmful to the public schools and the private schools, also.

Q Mr. Secretary, I have a question about this report that you're putting out today. It's sort of a chicken and egg question. Doesn't it seem common-sensical that students who plan to go to college would take algebra and geometry and students who don't would not, and so that's what your study shows, rather than showing if you take algebra and geometry, that somehow propels you to go to college?

SECRETARY RILEY: Well, I think that's right if you had children making adult choices very early. And the problem is, we need in the school systems in the states and the school districts and the schools need to let children know very early that we expect more of them. We expect them to think about college.

An awful lot of kids are either told or signaled at a very young age that they're not college material, that's for someone else, way before they have had a chance to prepare themselves to go to college. So I think the schools need to take all young people and make them think better of themselves and make them have higher expectations about what they can do.

And then when they approach middle school, we do very well on the early basics. The TIMSS test 4th grade showed we were second in the world only to Korea in science -- in the 4th grade. That's poor children, wealthy children -- to hold this very diverse, large country.

Then you get on up into the 8th grade; we drop down to where we're just about barely average. So we're very high in the 4th and we drop down to about average in the 8th grade.

So what happens between the 4th and the 8th? Well, in math, our observation is -- and some of these studies are showing it -- we just kind of continue on with arithmetic, and let's wait -- you might, can't handle anything more than that. Of course, we used to, unfortunately, have tracks into general math, or whatever, which was a ticket to nowhere.

So what we think is that counselors, people who are planning for schools' curriculum, course work and so forth in the 7th and 8th grade should realize the very serious importance for all children taking algebra in the 8th grade. If they do, it then opens up the 9th grade for geometry. And then if they want to go on to advanced math, the door is wide open to do that. If they don't take algebra in the 8th grade, they get on into high school and it's amazing how that just pulls the curtain down on their future. We think that's very good information.

But to say that a young child who is planning, themselves, to go to college so they choose to take algebra is probably right, but then there's another 75 percent of the children out there who should be told that if they work hard, if they take these tough courses, they, too, can go to college.

Q Mr. Secretary, what significant opposition is there to broadening the offering of algebra in the 8th grade, and how does that in any way relate to the President's push for national student tests?

SECRETARY RILEY: Well, it relates a lot. First of all,, there's no real opposition, but only 25 percent of American 8th graders have had algebra. And in Japan it's 100 percent. There's a reason for that. The Japanese have very clearly figured that out, the very thing that this longitudinal study shows. So we think that is very, very important to get that 25 percent to 100 percent. That's one thing.

And then you ask how does it connect up with the President's test? It's very clear. The test in the 8th grade is tied to NAEP. NAEP then has algebra and some geometric principles in the 8th grade test. That's what the sample test is now. It's not like we're adding anything new. But then, obviously, if the test then is a national test, states decide to take it, school districts decide to take it, then they'll say we've got to prepare these children to be able to take algebra in the 8th grade. And they should. And that's then -- we see a very powerful focus then being

made on reading in the 4th grade, math in the 8th grade including algebra, and that that will just have all kinds of good results in this country, by focusing school districts and schools on those two subjects at those grades.

Q You would use the test then to encourage the broadening of 8th graders taking algebra. But is there not another way to do that? I mean, if this is standard knowledge, the benefits of it, why don't schools adopt it more on their own? Why is the test necessary to increase --

SECRETARY RILEY: Well, the test -- and you're asking a very good question, because it gets to the real root of why the test is important, to me. The test focuses the nation -- the nation -- not a school, not your child, or whatever -- you get the information on your child, but it focuses the nation on a priority. And the test doesn't tell you how to teach math, it doesn't tell you what you do to prepare for it or whatever; all it tests is what you know. Then the school district and all decides that. But if it's a national test and Americans have bought into it, that all of our children ought to be able to read independently by the 4th grade, do basic math by the 8th grade including algebra -- if that's done, I'll tell you it would be revolutionary in terms of the success we would have in education. So I think it's enormously important.

Q Mr. Secretary, maybe I'm dense, but isn't it the obvious that if you achieve within -- every teacher sets out a lesson plan and says this is what you need to do to master this particular subject, is it absolutely necessary that a national test be adhered to in order to know what the obvious is? You ought to know if your kid is achieving or not in a particular subject.

SECRETARY RILEY: Well, there's two ways to look at that, too. You know, you've seen the chart we've had looking at various states on the NAEP test, but the NAEP test which is given out there now and looks at in a sample way -- you understand, just a sample test. If you took the test you might take one-seventh of it and you come out with a national average. This test you take the whole test and we know how you stood on math in 8th grade and reading in 4th. But NAEP then looked at the various states and it looked at -- I'm reluctant to call states, but one was South Carolina, one was Louisiana, Wisconsin, as I recall -- the local test there said reading in the 4th grade up in the range of 80 percent proficient readers. That's the state test.

NAEP, the national sample test taken in the same state, said it was in the range of 15 percent to 20 percent. And don't hold me to the exact numbers, but I've got the charts. But that came from the NAEP test.

So you see, a kid, then, in one of these states could think -- their parents could think they're reading wonderfully well. Compared to a national scale, they are doing very poorly and they don't know it. And what we are saying is, there's no reason in the world to keep that information from a parent. And people say, well, you know, children over here in a poor section don't do well, so why

give them a test? Well, that's a terrible thing to say in this democracy. You give them a test because every child there is important and every child there must know how to read and every child there should know basic math and algebra in the 8th grade. And every individual there is important, and don't group this school, or it's done poorly or whatever, and say it's that way, so let's get over here and worry about college.

So I think it's very, very important to single in on every child and then to have a national challenging test to raise those levels of interest. And I'll tell you this: When the test is given, there are going to be a lot of disappointed, concerned people, because it's a high challenging test.

Then, that's when the important part comes. That's when the system reacts to the tests, and the parents say, wait a minute, my child's in the 4th grade and can hardly read. Then, the school district and the school can all come together. You look in Seattle. I was so pleased reading an article in Seattle the other day. Seattle gave a tough test. And I mean it was -- everybody was very concerned about it. They did poorly; a lot of kids did poorly. So the reaction was very positive. Not criticize the children, not kill the test, but let's improve the schools to where the kids do well in the test.

Q So you have all these battery of tests that students are already taking. How could they possibly be so out of whack with what should be obvious levels of achievement?

SECRETARY RILEY: Well, they are.

Q In that test I think --

SECRETARY RILEY: I know. And the fact is they're all over the ball park. Delaware's local test is much harder than NAEP. I mean, you could test in Delaware reading basic, and in NAEP you would be reading proficient. You see what I mean? Delaware is way up here and Louisiana is down here. That's just the way it is. So, really, it makes a lot of sense to have a national test so everybody will know how their children stand, teachers will know what basic improvements are needed, but the important thing is to focus the nation on these basic skills of reading and math.

Q Mr. Secretary, two questions about the national test. Number one, a few minutes ago in making the case about why the administration opposes the voucher program for Washington, D.C., you said essentially we know where the problem is and we know how to better spend the money to solve the problem in this Washington, D.C. Isn't that precisely what opponents of the national tests say, that we ought not spend the money, we know how to fix schools and the money would be better spent fixing the schools rather than testing?

That's number one, and I've got a follow-up.

SECRETARY RILEY: Let me follow that again. You say the opponents of testing --

Q Yes, the opponents of testing say we don't need tests, we know how to fix schools --

SECRETARY RILEY: Yes, the answer I just gave -- let me answer that first -- that I gave this gentleman is the answer to that in my judgment, every student is important. And if you say this school does poorly, why test the children; they're poor, so don't worry about them.

Q What they're saying is don't spend the money on the test, apply the money that you would have spent on the test to fixing that school. Bypass the test, go in and fix the school.

SECRETARY RILEY: I guess it was Deming who said, you can't improve something you can't measure. Really, measurement is very, very important -- real measurement. If I'm a parent and my child is in that school and they say, you know, we don't need to test your child, we know he's going to do poorly; well, I want to know that. And if he does poorly, I want to know how. What is he weak in, in reading? What is he weak in, in math?

Every parent's entitled to that in this country, in my judgment and not to be grouped into some -- you're in this poor neighborhood, so we know you're going to do poorly, why test you? That's not fair to any child in that neighborhood.

Tell me the other.

Q The second question, if I could follow up, which is -- you talk about how, once you did the national tests, that will force school districts -- "force" is my word, not yours --

SECRETARY RILEY: Challenge --

Q -- to change their curriculums in order to better -- to do better on the test. Isn't that precisely what opponents of the test fear, that it becomes the federal government's through its test, forcing alternations in local school district policy? You say for good reasons; they say for bad reasons.

SECRETARY RILEY: Yes.

Q Isn't that the nub of the debate?

SECRETARY RILEY: Well, of course, what I say is that we don't tell them how to teach reading. All we propose is to test can the child read. And if they -- you can have two completely different ways of teaching reading. And you can look, then, if this child can read and this one can't, then that's good information for them. We don't say which is best or which is worst; all we propose to do is to test the child in reading, which is a very basic skill, we don't get into history and science and some of those very controversial ideological things; basic skills -- you either read or not. And

then, with math it's the same way, and algebra. So we say it's very basic skills and it's a very fair way to look at it.

And you say -- some say that that might control curriculum, and all I say to that is we don't get into curriculum at all. All we test, all we propose -- and it's voluntary. If somebody is worried about that, all they have to do is say we don't want the test. We think it's going to catch on and we think the people in this country are going to almost look at it as a patriotic thing, to get involved in getting this country to read well, getting this country to do math well, and getting our children ready for college and important jobs.

Q But you do think it will influence curriculums, sir, when you said a moment ago these tests will shake up the status quo and make things happen.

SECRETARY RILEY: Absolutely.

Q Well, then --

SECRETARY RILEY: Well, I'm saying we don't control curriculum. We're looking at can a child read, and if a child can't read it ought to shake up something. There's curriculum, it might be text books, it might be teacher preparation, it might be parent involvement, it might be technology, it might be violence in the school, drugs, construction. It will shake up something. And we want something shook up. That's what we want to do because if they're not reading then something needs to happen. But we don't get into curriculum. I want to make that clear, and I'll get 7,000 letters. We don't get into curriculum; we simply propose to measure basic skills, what they can do, and not how they learned it.

Q Where are the teachers unions with you on this?

SECRETARY RILEY: On the testing? I think they support it. I think they -- as far as I know, they -- I was trying to think -- there's two of them and I know the AFT -- I think both teacher organizations support the testing proposal that we made.

Q Secretary Riley, since you say mathematics is the opportunity, speaking at today's event, why is it that your office hasn't mandated algebra and geometry for every child?

SECRETARY RILEY: Because our office cannot do that and we would not like to do that. Education is, as I've said many times to you all and to others, is a state responsibility and it's a local function. The control of education is in the state, basically under our system. It's very similar to Brazil, by the way, which was very interesting, and in my trip to Brazil that's all they wanted to talk about, was education. But it's a state responsibility. It is illegal really for us to put out a federal curriculum.

So we want to do things to help the states and help the school districts, and measurement is one of them. We think that is real accountability. Anybody who is into accountability ought to be

into true measurement because that makes -- that encourages, challenges states and school districts to improve their schools.

Q Secretary Riley, can I ask a follow-up to an answer you gave to Leo on vouchers? Do you think private and church schools really will try to scam people out of their vouchers? And also, did you mean to suggest that poor people aren't bright enough to know that they're being scammed by these schools?

SECRETARY RILEY: No. I started off saying that I've got great confidence in private and parochial schools. Some of them are the highest quality schools in the country. And we are involved with them in some ways, as you well know, with Title I and we've been all through that Aguilar versus Felton. But if you have a private school and you've got a voucher, then there is a complication in making that -- keeping that private or having public accountability. I mean, I think anybody can see that. That's not saying anything about any strong private or parochial school.

But a lot of the stronger schools, of course, charge more than $3,200 a year tuition. Some of them don't. Some of them, they could come within that range, and some of those are full. But I still say -- and I don't want to in any way infer that private and parochial schools are any kind of a bad choice. I think it's a wonderful choice for people to have, but I think they ought to stay private, stay parochial, and that vouchers is a very bad system.

And I don't quite understand what you're saying, but if you have -- I do think this -- that if you have poor people with a voucher, it certainly could cause entrepreneurs to then try to move into that zone. Now, that's not to say those good private and parochial schools -- I'm not talking about them, obviously. I have to handle higher education gate-keeping, and it is hard. I've had to close down -- not close down, but deny federal funds, Pell Grants and so forth, student loans, to, like, 700 colleges and universities and schools. And it, in substance, closes them down. And that's hard. That's a job, though. That's connecting up with them. And I don't know how that would be done on a K through 12 system, but that's the problem in higher education. Some of those schools aren't schools at all and we have to then come in and say that. And that is very, very difficult and it's an accountability responsibility that is very, very difficult.

Q Can I just follow that last point? So, as a matter of principle, the principle of the federal government subsidizing colleges and universities, private and parochial schools at the college level, it's okay, but it's not okay as a principle, assuming you could get around this one issue that you just raised, in secondary or elementary schools?

SECRETARY RILEY: It's two totally different things. The state constitutions primarily, or state law -- usually, it's the state constitution -- says that the state will provide free public education for every child in the state. That, of course, under court interpretation is K through 12. That is the state's responsibility; not the federal government, but the state. And it covers all

children. It covers disabled children; it covers brilliant children; it covers whatever.

And then after grade 12, there's no such state constitutional or legal requirement to provide free public education. So in higher education, you get out of the 12th grade, then our

programs deal with the individual. They're adults then, too, but there's no state control of the system and the state responsibility. So as far as a child going to a religious school in college, it's no different with us -- we deal with the child -- than if they're going to a private school or a public school. But it's totally different. One is K through 12; that's state. And the other is adults who are not in the state-protected system.

Q What do you think of the salaries college presidents are getting, Mr. Secretary? Did you read about that? Did you read about these high salaries these college presidents are getting?

SECRETARY RILEY: I haven't, no. Something recent?

Q Yes.

MR. MCCURRY: It looks like a good line of work, though. (Laughter.)

SECRETARY RILEY: I recommend Mike -- (laughter.)

THE PRESS: Thank you.

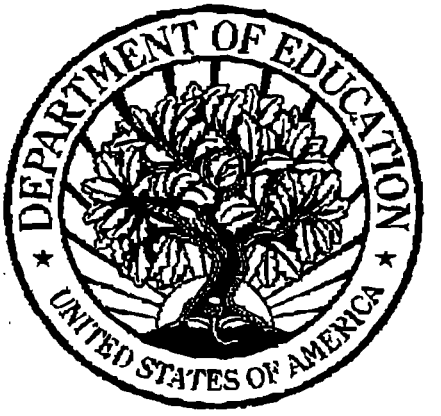
END 1:50 P.M. EDT

Final

MATHEMATICS EQUALS OPPORTUNITY

White Paper prepared for
U. S. Secretary of Education Richard W. Riley

October 20, 1997



A Letter from the Secretary of Education

Many parents, students, and educators in the United States are beginning to understand that mastering mathematics is a gateway to college. The key to the "gate" is taking algebra or courses covering algebraic concepts by the end of the 8th grade. However, many 8th and 9th graders may be behind in their course taking to get on the road to college.

Recent analyses by the U.S. Department of Education indicate that high school students who take algebra, geometry, and other rigorous mathematics courses are more likely to go on to college. This is true regardless of their family income. In fact, the benefit of taking rigorous courses is greatest for students from low-income families. Students who take chemistry, a subject that requires a firm grasp of mathematics, are also more likely to go to college. Other research tells us that the advantages of a solid mathematics background are not limited to the college bound. Workers who have mastered mathematics earn more and are less likely to be unemployed than workers who are less proficient in mathematics.

However, not all students have access to rigorous mathematics courses -- either because their school does not offer everyone a full selection of challenging courses, or because not all students are prepared for and encouraged to take them. The results of the recent Third International Mathematics and Science Study (TIMSS) confirm that many students enter high school without a solid grounding in mathematics, closing doors very early for further education and better careers.

The implication is clear: The 8th grade is a critical point in mathematics education. Achievement at that stage gives students a leg up on taking rigorous high school mathematics and science courses important for later success.

As a nation, we must ensure that all our students develop the mathematics foundation they need by the end of the 8th grade--and then build on it throughout high school. We challenge parents, schools, community groups, higher education, and employers to ensure that all children have access to rigorous mathematics courses and a chance at college. The U.S. Department of Education stands ready to assist them by providing financial aid to college students and supplementing Advanced Placement Exam fees for students who demonstrate need. Additionally, the Department provides funding through Title I and other programs of the Elementary and Secondary Education Act (ESEA) to assist schools in upgrading mathematics teaching and learning nationwide. It is also offering a voluntary national test in 8th grade mathematics, so that parents and schools can benchmark their students' performance. Together, we will help to ensure that all students are given the opportunity to excel.

Sincerely,

Richard W. Riley

Table of Contents

Executive Summary

In the United States today, mastering mathematics has become more important than ever. Students with a strong grasp of mathematics have an advantage in academics and in the job market. The 8th grade is a critical point in mathematics education. Achievement at that stage clears the way for students to take rigorous high school mathematics and science courses—keys to college entrance and success in the labor force. However, most 8th and 9th graders lag so far behind in their course taking that getting on the road to college is a long way off.

This report highlights the following findings:

- **Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not.** Data from the National Educational Longitudinal Study (NELS) reveal that 83 percent of students who took algebra I and geometry went on to college within two years of their scheduled high school graduation. Only 36 percent of students who did not take algebra I and geometry courses went to college. While nearly 89 percent of students who took chemistry in high school went to college, only 43 percent of students who did not take chemistry went to college.

- **Algebra is the "gateway" to advanced mathematics and science in high school, yet most students do not take it in middle school.** Students who study algebra in middle school and who plan to take advanced mathematics and science courses in high school have an advantage: approximately 60 percent of the students who took calculus in high school had taken algebra in the 8th grade. However, 1996 NAEP data reveal that only 25 percent of U.S. 8th graders enrolled in algebra, and that low-income and minority students were even less likely to take algebra in the 8th grade.

- **Taking rigorous mathematics and science courses in high school appears to be especially important for low-income students.** Low-income students who took algebra I and geometry were almost three times as likely to attend college as those who did not. While 71 percent of those who took algebra I and geometry went to college, only 27 percent who did not take those courses went on to college. By way of comparison, 94 percent of students from high-income families, and 84 percent of students from middle-income families who took algebra I and geometry in high school went on to college. Sixty percent of students from high-income families and 44 percent of students from middle-income families who did not take algebra I and geometry went to college.

- **Despite the importance of low-income students taking rigorous mathematics and science courses, these students are less likely to take them.** Students from higher-income families are almost twice as likely as lower-income students to take algebra in middle school and geometry in high school. They are more than twice as likely to take chemistry.

Other important findings include:

- **Mathematics achievement depends on the courses a student takes, not the type of school the student attends.** Students in public and private schools who took the same rigorous mathematics courses were equally likely to score at the highest level on the NELS 12th grade mathematics achievement test.

- **Students whose parents are involved in their school work are more likely to take challenging mathematics courses early.** Students whose parents were involved in their education were more likely to take courses like algebra and geometry in the 8th and 9th grade than students whose parents were not involved.

- **The results of the Third International Mathematics and Science Study (TIMSS) reveal that the middle school mathematics curriculum may be a weak link in the U.S. education system.** While U.S. 4th graders scored above the international average in mathematics and science, U.S. 8th graders scored below average in mathematics, and only slightly above the international average in science. Initial analysis of TIMSS data also shows that the middle school mathematics curriculum in the U.S. is less challenging than in other countries. The curriculum of average 8th-grade mathematics classrooms in the U.S. resembles 7th grade curriculum elsewhere. Although algebra and geometry are integral elements of the middle school curriculum in other countries, only a small fraction of U.S. middle schools offer their students these topics.

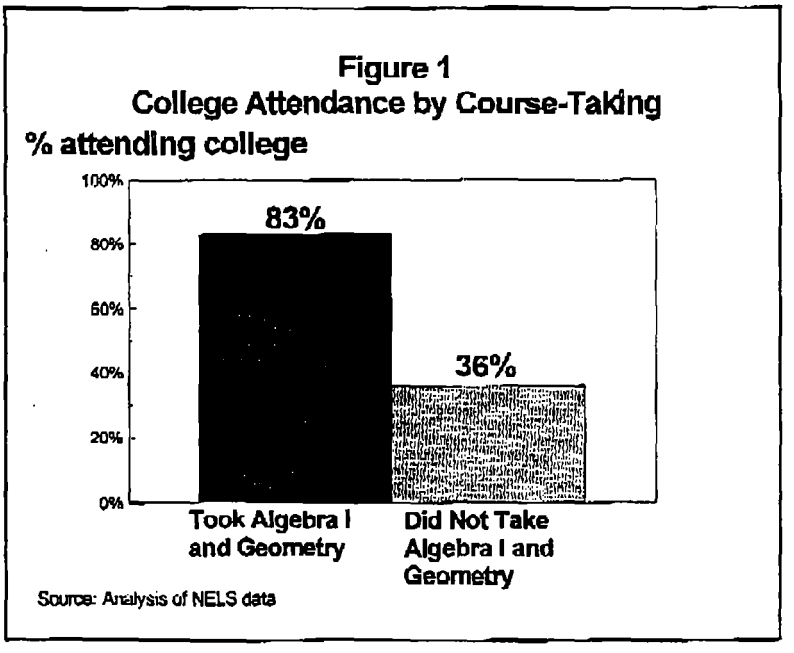
Algebra in the Curriculum

Making a successful transition from arithmetic to more advanced mathematics, including algebra and geometry, has often been difficult for students. As a result, many mathematics programs in the U.S. are now systematically incorporating some fundamentals of algebra and geometry into the upper elementary grade curriculum. In these programs, 5th, 6th and 7th grade students are representing and solving equations, characterizing patterns and rates of change among variables, and using other fundamental algebraic concepts.

In addition, some middle and high schools are taking a new approach to advanced topics. While many schools offer the traditional model of separate courses for pre-Algebra, Algebra I, Geometry, Algebra II, Trigonometry, pre-Calculus and Calculus, these schools are integrating them. This approach is consistent with practices in other industrialized nations, which integrate algebra, geometry, and other topics throughout the elementary, middle, and high school years and offer a significant component of algebra in the 8th grade. Building a firm foundation in algebra during the elementary and middle school years eases the shift from arithmetic to advanced topics, whatever the format of students' new curriculum. NELS and NAEP, the two sources of national mathematics course-taking data analyzed in this brief, employ traditional courses titles, such as "algebra I" and "geometry." Thus, these titles are used throughout the brief.

Mathematics and Future Opportunities

The Importance of Mathematics for College Entrance



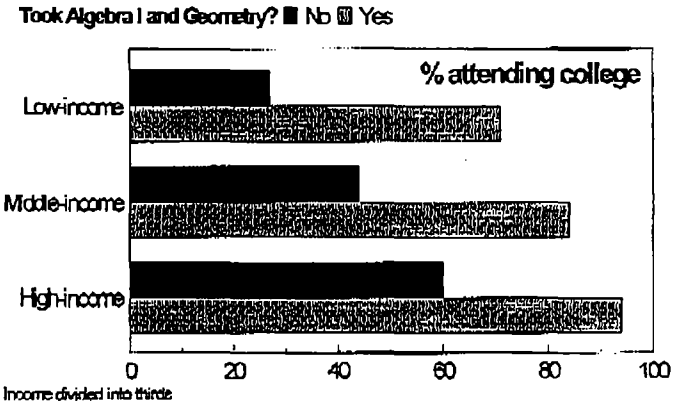
Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not. Data from a longitudinal survey of students who were in the 8th grade in 1988 (National Educational Longitudinal Study or NELS) reveal that 83 percent of students who took algebra I and geometry enrolled in college[1] within two years of their scheduled high school graduation. Only 36 percent of students who did not take algebra I and geometry went to college (Figure 1). Similarly, students who take rigorous science courses in high school are much more likely to go to college. While nearly 89 percent of students who took chemistry entered college, only 43 percent who did not take chemistry went to college.

Students who take more rigorous mathematics courses also show higher gains in mathematics achievement (measured by the mathematics achievement test given as part of NELS) than students who take less challenging courses, even when controlling for initial achievement. For example, among students who initially began at the same level of mathematics proficiency in the 8th grade, students who had taken algebra II or geometry by the 10th grade experienced greater gains, on average, than students who had taken no algebra or only algebra I during that period.

[1]Throughout this report, the term "college" is used to refer to any postsecondary education taken at a public, private not-for-profit, or private for-profit institution.

Students of all income levels who take rigorous mathematics and science courses in high school are more likely to go to college, and among low-income students (students in the bottom third of the income distribution)[2], the difference is particularly dramatic. Students from low-income families who took algebra I and geometry were almost three times as likely to attend college as those who did not. While 71 percent of low-income students who took algebra I and geometry went to college, only 27 percent of low-income students who did not take algebra I and geometry went on to college. The differences are also dramatic among students from middle- and high-income families: 94 percent of students from high-income families, and 84 percent of students from middle-income families who took algebra I and geometry went on to college, while 60 percent of students from high-income families and 44 percent of students from middle-income families who did not take geometry still went on to college (Figure 2).

Figure 2
College Attendance by Income and Course-Taking



Unfortunately, many students, in particular low-income students, do not take these rigorous mathematics and science courses. According to NELS, 63 percent of all students took algebra I and geometry and 50 percent took chemistry. Students from low-income families, however, were far less likely than their more advantaged peers to take these rigorous courses. Among students in the bottom third of the income distribution, 46 percent took algebra I and geometry and only 33 percent took chemistry. By way of comparison, fully 81 percent of students in the top third of the income distribution took algebra I and geometry, and 72 percent took chemistry. The differences are similar for other rigorous mathematics courses (Table 1).

[2]Income data are based on total family income reported by parents. Low, middle, and high income groups each contain approximately one-third of the sample. The "all" category includes additional observations with missing income data.

Table 1: Course-Taking Patterns of NELS Students

	Percent of Students Taking Course			
	All	Bottom Income	Middle Income	Top Income
Algebra I and Geometry	**63**	**46**	**68**	**81**
Trigonometry	18	10	19	30
Chemistry	50	33	52	72

Accounting for course-taking patterns dramatically reduces the difference in the rate of college-going between low- and high-income students. Students from high-income families are almost twice as likely to attend college as students from low-income families (86 percent compared to 44 percent) when course-taking patterns are not accounted for. However, comparing only students who have taken rigorous courses to one another, students from low-income families go to college at rates much more similar to students from middle- and high-income families (Table 2). For example, among students who took chemistry in high school, 95 percent of high-income students, 89 percent of middle-income students, and 79 percent of low-income students went to college. When low-income students take rigorous courses, income effects on college entrance rates diminish greatly, although they do not disappear.

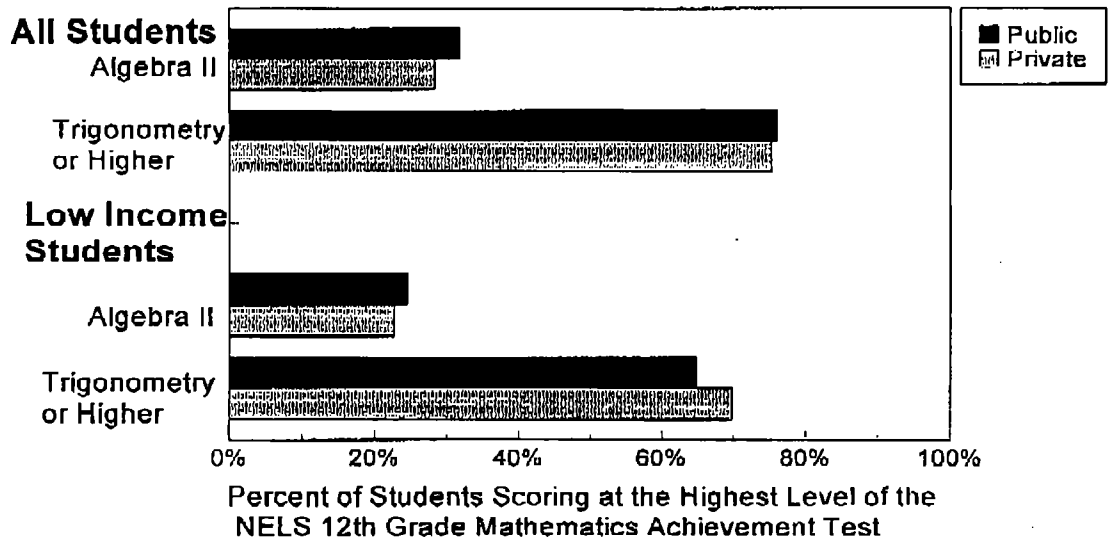
Table 2: College Attendance by High School Course-Taking Patterns of NELS Students

	Percent of Students Attending Postsecondary Education				
		All	Bottom Income	Middle Income	Top Income
	All	63	44	69	86
Algebra I and Geometry	**Yes**	**83**	**71**	**84**	**94**
	No	**36**	**27**	**44**	**60**
Trigonometry	Yes	94	90	92	98
	No	59	42	66	83
Chemistry	Yes	89	79	89	95
	No	43	31	50	68

Public Versus Private Achievement Depends on Course-Taking, Not the Type of School

In general, the mathematics courses students take in high school determine achievement more than the type of school they attend. While recognizing that a great deal of diversity exists in public and private schools, it is useful to note that when course-taking patterns are accounted for, the mathematics achievement of students in both categories of school is very similar. Public and private school students who took the same mathematics courses were almost equally likely to score at the highest level on the NELS 12th grade mathematics achievement test. This was also true for low-income public and private school students. Additionally, among both public and private school students of all incomes, students who had taken more rigorous mathematics courses were much more likely to score at the highest achievement level (Figure 3).

Figure 3
Mathematics Achievement by Highest Mathematics Course Taken



Achievement divided into thirds; Students in highest level scored in the top third
Source: Analysis of NELS data

1 Private schools include non-religious, Catholic, and other private schools

Mathematics in College, the Workplace, and the 21st Century

The benefits of taking rigorous mathematics and science courses extend to students heading into the job market and to both two- and four-year colleges. As technology becomes prevalent in the workplace, more and more workers will find they need to have strong backgrounds in mathematics and science--backgrounds which will have begun to form even before high school. Rigorous mathematics and science preparation is also important to students intending to go to a two- or four-year college or university. The level and number of mathematics courses that a student needs to take before and during college depend on the college and the major that the student wants to pursue. Mathematics- and science-related disciplines typically require that students have taken rigorous mathematics courses. Many other popular courses of study require advanced mathematics as well.

Two-year colleges often require all students to gain an understanding of intermediate algebra prior to graduation, regardless of their course of study. Many two-year colleges require all degree-seeking students to take mathematics placement exams prior to enrollment. High scorers may be exempt from taking certain mathematics courses, while low scorers may have to take remedial mathematics courses. Many of the most popular majors at two-year colleges--including Business, Nursing, and Computer Science--require more rigorous mathematics course work, such as statistics.

Four-year colleges and universities typically require more high school mathematics preparation for admission. Typical state four-year colleges and universities recommend, and in some cases require, that all students take at least three, and sometimes four, years of mathematics in high school. Data collected by the College Board reveal that in 1997, 68 percent of incoming freshmen at four-year colleges and universities had taken four years of mathematics in high school. Furthermore, almost all of these students had taken algebra and geometry, and more than half had taken trigonometry. Most state colleges require students to take mathematics placement exams upon enrollment. Colleges look favorably on Advanced Placement courses and often place students who have taken them out of introductory mathematics courses. While graduation requirements differ depending on the students' major, many popular majors, such as Business and Psychology, require students to take several more rigorous courses in mathematics or science.

In the job market, workers who have strong mathematics and science backgrounds are more likely to be employed and generally earn more than workers with lower achievement, even if they have not gone on to college. A national survey found that by age 30, high school graduates who had not furthered their education but had scored in the top quartile on the mathematics portion of the Armed Services Vocational Aptitude Battery (ASVAB--administered to civilians for study purposes) earned, on average, 38 percent more per hour than high school graduates who had not gone to college and had scored in the bottom quartile of the mathematic portion of the ASVAB. Similarly, the unemployment rate among high school graduates who scored in the top quartile of the mathematics test was only 4.4 percent. The unemployment rate was 10.3 percent

among high school graduates who scored in the lowest quartile. Workers who scored in the top quartile of the science section of the ASVAB also earned more, on average, and were less likely to be unemployed.

Mathematics ability will be even more important for well-paying jobs in the future. Some major firms already require job applicants to pass standardized mathematics and reading tests. For example, Diamond-Star Motors, a joint venture of Chrysler and Mitsubishi, tests all applicants for production and maintenance positions on their ability to do high school level mathematics. Authors Richard Murnane and Frank Levy have identified a set of "New Basic Skills," in their book of the same name, that non-college-bound high school graduates should master in order to get well-paying jobs in the modern labor market. The "New Basic Skills" that workers will need in order to earn a good wage include the ability to use mathematics skills and concepts **at least** at the 9th grade level.

Shortages in workers skilled in mathematics and science could affect U.S. performance in global markets. According to a recent report, *America's New Deficit: The Shortage of Information Technology Workers,* from the Office of Technology Policy at the U.S. Department of Commerce, as computer and data processing become more important to the economy, more and more workers skilled in mathematics- and science-related disciplines will be needed to maintain the U.S.'s international competitiveness. The report cites a survey by the Information Technology Association of America indicating that 50 percent of company executives in information technology report a lack of skilled workers as "the most significant barrier" to their companies' growth during the next year. However, the number of bachelor level computer science degrees awarded by U.S. colleges and universities declined more than 40 percent between 1986 and 1994, indicating that these problems are likely to persist.

Mathematics and Science in the Modern Job Market

Many jobs in today's labor market require a mathematics or science background. A number of these are among the fastest growing occupations nationally, and are not ones ordinarily thought of as "technical." Projections from the Bureau of Labor Statistics' (BLS) Occupational Outlook Handbook indicate that between 1994 to 2005, jobs requiring the most education and training will be the fastest growing and highest paying. BLS predicts that occupations requiring a bachelor's degree or higher will average 23 percent growth, almost double the 12 percent growth rate projected for occupations that require less education and training.

Many jobs that once required little background in mathematics now call for specific skills in algebra, geometry, measurement, probability, and statistics. According to an industry-wide standard, an entry level automobile worker needs to be able to apply formulas from algebra and physics to properly wire the electrical circuits of any car. The National Coalition for Advanced Manufacturing has defined 25 specific standards of mathematics and measurement among their national skill standards for what a competent worker should know and be able to do.

Several of the fastest growing job areas will reflect growth in computer technology and health services--fields that can require substantial mathematics and science preparation. Generally speaking, fields requiring a strong science base also require substantial mathematics preparation, as most academic science programs build upon a strong background in mathematics. Below are some of the jobs which BLS indicates require a mathematics or science background; while many of these jobs require mathematics or science course work beyond the high school level, all require at least a high school level background. The occupations that BLS projects will be among the fastest growing during the period from 1994 to 2005 are noted with a star (*).

Computer Scientists (*)
Systems Analysts (*)
Occupational Therapy Assistants and Aides (*)
Chemical Engineers
Civil Engineers
Aerospace Engineers
Medical Assistants (*)
Dentists and Dental Hygienists
Surveyors
Surgical Technologists
Dieticians and Nutritionists
Optometrists
Physical Therapists (*)
Roofers
Tool and Die Makers
Photographers
Financial Managers
Budget Analysts

Middle School: Getting on the Road to Challenging Mathematics and Science Courses

Laying the Foundation

> "Mathematics is the language of science, and algebra is the minimum vocabulary that scientists of every discipline use to describe their work."
>
> —Dr. George Castro, Associate Dean of the College of Science at San Jose State University

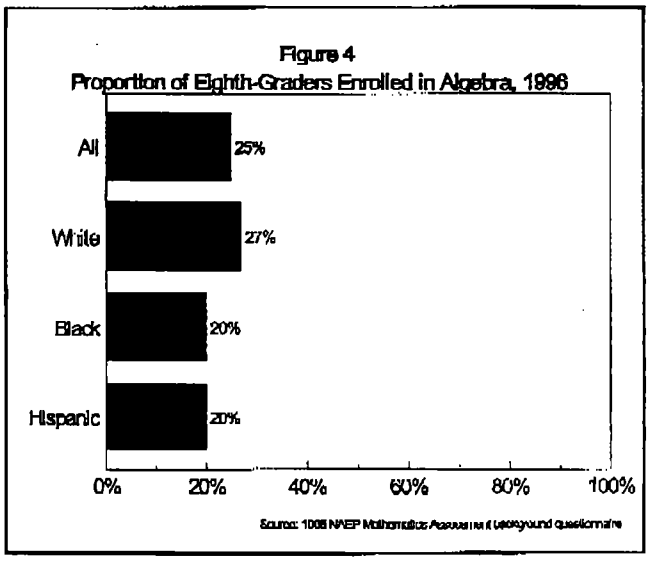
Algebra is the "gateway" to rigorous mathematics courses. Rigorous mathematics courses build upon the skills and concepts that students learn in earlier mathematics courses. Traditionally, students cannot take a rigorous mathematics course in high school until they have successfully completed one or more prerequisite courses. Algebra I, or another course that covers basic algebraic concepts, is the prerequisite for more rigorous mathematics in high school.

Students who plan to take advanced mathematics and science courses during high school and begin to study algebra during middle school are at a clear advantage. A rigorous sequence of mathematics spans several years. The traditional sequence of mathematics courses involves one year courses in algebra I, geometry, and algebra II, followed by a half-year course in trigonometry, a full- or half-year course in pre-calculus, and then calculus or an Advanced Placement course. Increasingly, schools are covering these rigorous content areas in courses that integrate algebra, geometry and other areas of mathematics such as statistics and probability, rather than teaching each separately. According to NELS, approximately 60 percent of the students who took calculus in high school had taken algebra in the 8th grade. The typical high school sequence of rigorous science courses (biology, chemistry, and physics) also necessitates an early background in algebra and geometry.

Students who do not take courses covering algebraic concepts early in their educational career risk closing the door on many important opportunities, including opportunities to take courses outside of mathematics and science. Some high schools require students to complete a specific package of courses, including mathematics and science, in order to graduate. By the junior and senior years, students who have not planned ahead have fewer options in choosing which courses they take. Students who do not complete prerequisite and required courses early enough not only risk being unable to take more rigorous courses in those disciplines later, but also may not have time in their schedules to take other courses that can help prepare them for college or a career, including foreign language, art, Advanced Placement, and "tech prep" courses.

Course-Taking Patterns in Middle School

Despite recent increases in the proportion of students taking algebra I in the 8th grade, in 1996, most students were not enrolled in this course. The proportion of 8th-graders taking the National Assessment of Educational Progress (NAEP) mathematics assessment who reported taking algebra has increased. In 1992, only 20 percent of students reported taking algebra. In 1996, the next year the NAEP mathematics assessment was administered, 25 percent reported taking algebra. This increase may be due to a number of factors, including the National Council of Teachers of Mathematics' (NCTM) call for including algebraic topics in the middle school curriculum.

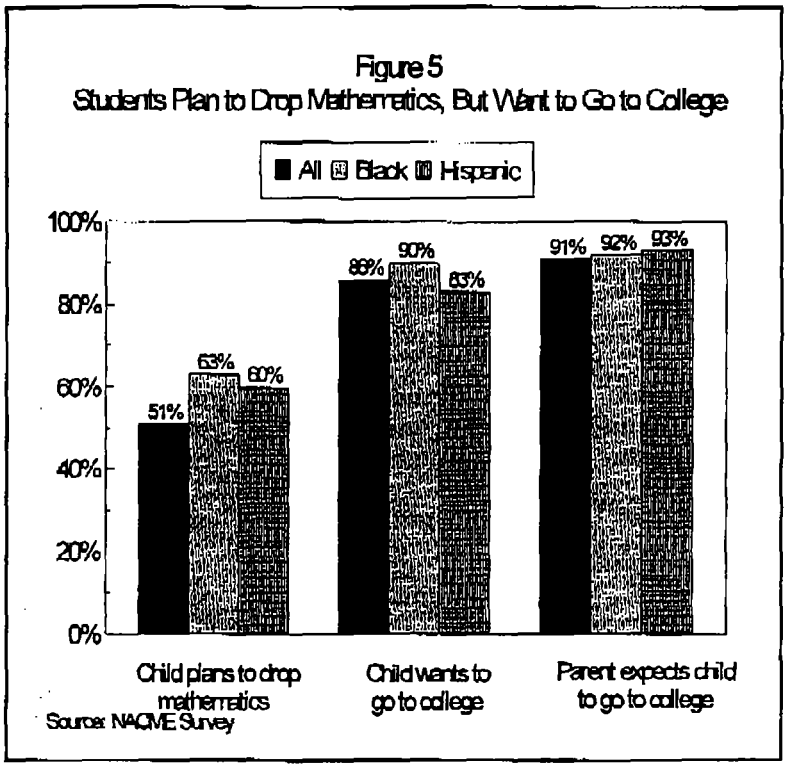


Minority and low-income students continue to be less likely to take challenging mathematics courses in middle school than other students. The 1996 NAEP data reveal that minority students are less likely to report being enrolled in algebra in the 8th-grade (Figure 4). The data also indicate that students from disadvantaged backgrounds are less likely to be enrolled in algebra during the 8th grade: While 29 percent of students who were not eligible for the national school lunch program reported being enrolled in algebra during the 8th grade, only 15 percent of students who were eligible for the national school lunch program were enrolled in algebra.

While the number of students taking algebra courses has increased, recent evidence suggests that the content of these courses has remained rigorous. Many states have recently increased mathematics requirements for high school graduation, often requiring that students take more years of mathematics than were required in the past, or mandating that students complete certain courses. A recent study supported by the National Science Foundation (NSF) examined the content of mathematics courses in schools in several of the states making the most substantial changes in mathematics requirements. The study focused on basic courses, such as algebra I, which had experienced large enrollment increases because of more stringent graduation requirements. Despite the larger numbers of students enrolling in the courses, the study found that the content of these courses was essentially unchanged, indicating that more students were, in fact, being exposed to rigorous mathematics.

Parent and Student Attitudes about Mathematics and Science

Large proportions of middle school students indicate that they do not plan to take mathematics and science courses beyond what their schools require. A nationally representative survey of public school students and parents conducted by Louis Harris Associates for the National Action Council for Minorities in Engineering (NACME), Inc. found that large proportions of students would like to **stop** taking mathematics and science courses as soon as they can. Fifty-one percent of the 5th through 11th grade students surveyed indicated that they would take mathematics classes only as long as required, while 47 percent reported they would study science only as long as it is required. Distressingly, young minority students--5th through 8th graders who will soon be facing major decisions about which courses to take--were more likely to indicate that they planned to drop mathematics and science as soon as they were able to (61 percent planned to drop mathematics, and 58 percent planned to drop science). Minority students of all ages were more likely than other students to say that they would like to stop taking mathematics and science as soon as they could (Figure 5).



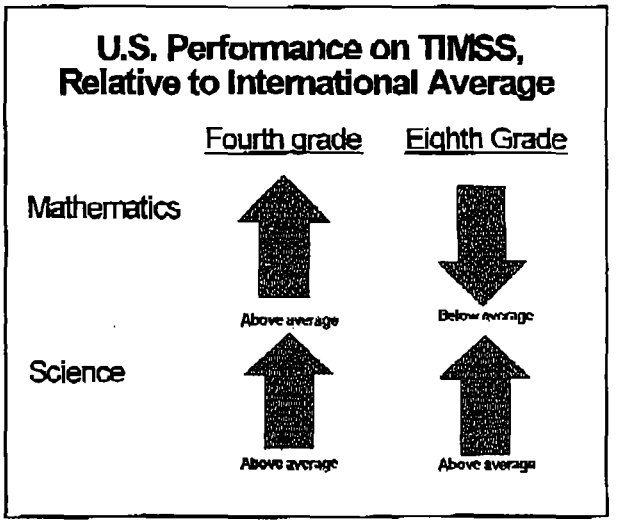
However, the same students indicate that they would be interested in going to college, and taking college-level mathematics courses. Eighty-six percent of all students surveyed said that they would like to go to college. Although less than half of the 9th- to 11th-grade students said that they planned to take trigonometry or algebra II in high school, nearly two-thirds said that they were interested in taking Advanced Placement courses. These contrasts signal that many students do not understand the importance of, and requirements for, taking rigorous mathematics and science courses in high school, including the need to take algebra by the 8th grade. In fact, only 25 percent of minority and 42 percent of non-minority 5th- through 8th-grade students recognized that if they did not take algebra they would not be able to take other mathematics classes in the future.

Parent and teacher involvement may make a large difference in students' decisions about mathematics and science. According to the NACME survey, ninety-four percent of students indicated that their parents' or guardians' advice was important to them in deciding what they would study in school, and 88 percent indicated their teachers' advice was important. Ninety-one percent of parents want their children to continue their education beyond high school. However, when 9th- through eleventh-graders were asked who decided which mathematics classes they would take, 79 percent indicated that they had made the decision by themselves.

Analysis of the NELS data indicates that students with greater levels of parental involvement are more likely to take advanced mathematics courses. Analysis of the course-taking patterns of the NELS students who were in 8th-grade in 1988 reveals that regardless of whether the level of parent involvement was reported by the student, the parent, or the teacher, higher levels of parental involvement were consistently associated with higher likelihoods of taking rigorous mathematics courses. While only 8 percent of those students who said that they did not discuss programs at school with their parents took algebra I by the 8th grade, 17 percent of those who said that they discussed school programs three or more times during the previous semester took algebra I by the 8th grade. Students whose parents or teachers indicated greater levels of parental involvement were also more likely to take advanced courses. Thirty-seven percent of students whose parents said that they rarely talked to their child about high school plans took geometry by the 10th grade, while 48 percent of those students whose parents said they regularly spoke to the child about high school plans took geometry by the 10th grade. While 27 percent of students whose teachers said their parents were not involved took geometry by the 10th grade, a full 63 percent of the students whose teachers said that their parents were very involved took geometry by the 10th grade.

Mathematics in the U.S. Today

International Comparisons of Middle School Mathematics and Science Proficiency



Recent findings from the Third International Mathematics and Science Study (TIMSS), indicate that the mathematics curriculum from grades five through eight may be a weak link in the U. S. educational system. Newly available data from TIMSS (the most comprehensive international comparison of schools and students ever undertaken) reveal that U.S. 4th graders scored above the international average in both mathematics and science. Among 25 other participating nations, only Korea performed better than the U.S. in 4th grade science, and only 7 of the 25 other countries did better than the U.S. in 4th grade mathematics. These findings are in contrast to earlier findings from TIMSS that indicate that U.S. 8th graders perform slightly below the international average in mathematics, and only slightly above the international average in science. In fact, only one country--the U.S. in mathematics--falls from above the international average at 4th grade to below the international average at 8th grade.

The U.S. expects less of its middle school students compared to high performing nations. TIMSS data suggest that one reason U.S. students do less well at 8th grade is that the middle school mathematics curriculum in the U.S. is significantly less challenging than curricula in other countries. In Germany and Japan, virtually all students in grades 5 through 8 move beyond arithmetic to the foundations of algebra and geometry. By 8th grade, mathematics courses in virtually all other countries participating in TIMSS include significant algebra and geometry, while in the U.S., only students in college-preparatory classes receive significant exposure to algebra, and very few students study geometry. As a result, the content taught in U.S. 8th grade mathematics classrooms is usually at a 7th-grade level compared to the 40 other nations in the TIMSS study.

TIMSS also found that U.S. mathematics classes require students to engage in less high-level mathematical thought and solve fewer multi-step problems than classes in Germany and Japan. A U.S. mathematics teacher's typical goal is to teach students the mechanics of solving a problem versus understanding the concepts behind it, while a Japanese teacher's goal is to help them learn the basics as well as understand the relevant mathematical concepts. In a typical U.S. classroom, students follow the teacher as he or she leads them through solutions to mathematics

problems. In Japan, students are asked to solve problems, present them to the class, and describe how they approached the problem to increase their own understanding.

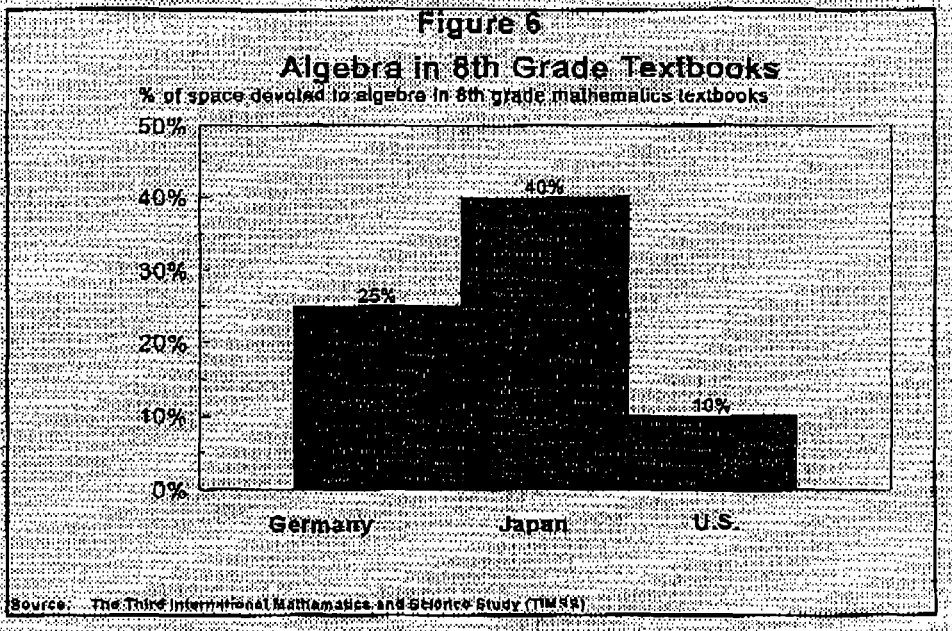
How Does Our Curriculum Compare Internationally?

The 8th grade mathematics curricula in both Germany and Japan are more advanced than in the United States. The TIMSS analysis of U.S. curricula examined both the content of textbooks and how it is implemented in classrooms.

- An analysis of curricula in the U.S. and other countries found that algebra and geometry occupy more space[1] in German and Japanese textbooks than they do in the textbooks used by a majority of U.S. 8th graders (Figure 6).

- Analyses of curriculum implementation make clear that in the middle school years, the U.S. still focuses on arithmetic. For example, 40 percent of U.S. 8th grade mathematics lessons included arithmetic topics, whereas only 13 percent of Germany's and none of Japan's lessons at the 8th grade level included these topics. The major focus of curriculum taught in these countries is on algebra and geometry.

Figure 6



[1]Space is defined in terms of the percentage of a textbook or guidebook that is devoted to particular topics/blocks. Topics include such items as formulas, geometry, numbers, and estimation. Blocks are sub-units of topics that are parts of a textbook and which might include individual pedagogical suggestions, individual examples, individual testing, narrative blocks, graphic blocks, suggested activities, and mathematical problems.

Promising Practices

Across the country, there are many promising mathematics and science practices underway. Many of these are responsible for increases in the numbers of students taking rigorous courses in mathematics and science. Just as important, many students are finding that they do quite well in these more advanced courses. There is, of course, no one formula to success. Highlighted here are a number of places that demonstrate effective strategies.

Taking the Right Courses. In 1990, the College Board launched EQUITY 2000 to increase minority enrollment in college preparatory mathematics courses. Originally piloted in six communities, EQUITY 2000 requires participating school districts to phase out lower-level mathematics in favor of all students taking college preparatory curriculum--beginning with algebra and geometry. EQUITY 2000 influences policies, curricula and student academic development at all grade levels, but particularly grades six through nine. These are critical years for mathematics education. During this period, parents, students, and educators make key decisions about which courses students should take and how they should begin planning for education and careers after high school. Equity 2000 provides on-going professional development to help teachers work with mixed-ability classes. It also trains administrators and teachers to use student enrollment and achievement data to drive school-based decision-making, helps schools establish support services for students who need extra time and effort to learn challenging content, and encourages and supports parents to become advocates on behalf of their children.

Increased parental involvement is a priority in Equity 2000. It recognizes the important role that parents play in nurturing and reinforcing their children's desire to attend college. Equity 2000 has sponsored Saturday and summer academics on college campuses for entire families. It also sponsors Family Math nights in which parents and students learn mathematics concepts together.

Results at the six pilot sites indicate that:

- All sites dramatically increased the percentage of students enrolled in algebra I by the 9th grade, and in three pilot districts, all 9th graders enrolled in algebra I.

- The percentage of students passing algebra I did not decline significantly, and in some cases rose, as more students from the discontinued lower tracks began enrolling in algebra classes.

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www.collegeboard.org/equity/html/indx001.html

Advanced Placement Participation and Scores on the Rise. The College Board's Advanced Placement (AP) Program was started nearly four decades ago to enable students to complete college-level studies while still in high school and to obtain college credit or placement. AP courses are widely recognized as setting the standard for high levels of academic achievement in high school. Today more than 500,000 students in about half of the nation's high schools take at least one AP course. Dramatically increased participation in AP courses in Texas and South Carolina illustrate the success of AP-based reform initiatives in two states.

Texas: The Advanced Placement Incentives program was developed in the Dallas, Texas area by O'Donnell Foundation in reaction to low rates of college attendance and poor college preparation. The Advanced Placement Incentives program reward results in AP courses in mathematics, science, English, and the arts by providing performance-based financial incentives to teachers, school and students. Teachers are given financial incentives as well as registration and fees for attending College Board AP teacher training during the summer, and to teach AP courses. Students who complete the Advanced Placement course may take the AP exam at half-cost (the total cost for an AP exam is about $73). Those who score a three or better (on a five point scale) are given financial incentive and reimbursed for the cost of the exam.

In five years of operation in nine Texas public schools, the O'Donnell foundation reports that:

- The year before the program began in nine typical public high schools, 48 students took AP exams in mathematics, science, and English, and received a three or better. In the fifth year of operation, 1,099 students took AP exams and 521 received a score of three or better.

- In nine high schools in the Dallas Independent School District, the eighth largest inner-city school district in the country, with 85 percent minority enrollment, growth in AP participation has been outstanding. Students took 312 AP in mathematics, science, and English in May 1995, the year before the program started in the Dallas schools. In May 1997, the second year of the Dallas program, this number has grown to 1,750. The number of students scoring three or higher during that time period grew from 139 to 559.

- The Dallas school program has experienced proportional growth among female and minority students. The year before the program started, 94 females took exams in mathematics, computer science, and the sciences. In the program's second year, 452 female students took these exams.

- Minority participation has also grown in Dallas, from 64 7 African-American and Hispanic students taking AP mathematics, science, and English exams the year before the program began, to 734 in the program's second year.

South Carolina: With former Governor Riley's school reform package of 1984, South Carolina became one of the first states to legislate funding and other actions to boost student participation in AP classes. The state appropriated funds to train AP teachers and to help pay for AP exams, as well as required that public colleges accept AP courses if the student scored 3 or higher on the exam. As a result, from 1984 to 1997 South Carolina experienced:

- An increase in the number of students taking AP exams from 2,799 to 9,748.
- An increase in the number of AP exams from 3,461 to 14,890, with the mean grade remaining stable at approximately 2.7 - 2.8.
- An increase in the number of AP science exams (Biology, Chemistry, Physics) from 27 to 2,414.
- An increase in the number of AP math exams (Calculus AB and BC) from 46 to 2,767.
- Ninety-three percent of all the public high schools in the state participating in AP (184 of 197 public high schools).
- AP participation rates above the national average.

AP Exams Taken
(Eleventh and Twelfth Graders)

	1984	1997	Percent increase
South Carolina	3,461	14,890	430 percent
National	223,888	843,399	380 percent

Sources: College Board. *Advanced Placement Program, National and South Carolina Summary Reports, 1984 - 1997.*

Contacts:

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Columbia, SC 29201
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Patrick Moore
O'Donnell Foundation
100 Crescent Ct.
Suite 1660
Dallas, TX 75201
(214) 871-5800

Strengthening Curriculum and Instruction. Sponsored by the University of Pittsburgh's Learning Research and Development Center, the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project aims to raise low levels of student participation and performance in mathematics. QUASAR is an urban middle school demonstration project that fosters the development and implementation of improved mathematics instructional programs in economically disadvantaged communities. The program revolves around three key principles: (1) all students are able to learn a broad range of mathematical content; (2) all students can acquire a deeper and more meaningful understanding of mathematical ideas; and (3) all students can demonstrate proficiency in mathematical reasoning and complex problem solving.

In QUASAR schools, teams of mathematics teachers, school administrators and "resource partners"-- generally mathematics educators from local universities -- collaborate to develop, implement, and refine mathematics instruction. All project schools have eliminated most forms of academic tracking, replacing it with the development of deeper student understanding and high-level thinking and reasoning for all students. While curricula, teaching strategies, and approaches to professional development vary, all QUASAR sites include extensive attention to professional development and teacher support. Additionally, the University of Pittsburgh's Learning Research and Development Center provides schools with ongoing support and updated information on their progress.

Data indicate that QUASAR schools build teachers' capacity to improve the quality of their mathematics instruction. Students increase their capacity to think, reason, solve complex problems, and communicate mathematically and they do so while continuing to learn basic skills. QUASAR school students, particularly those who are from minority groups and whose English proficiency is limited, have increased their understandings across a range of important mathematical ideas. Additionally, QUASAR students in grade 8 performed as well as other students on basic and traditional items of the 1992 NAEP Mathematics Assessment. They performed better than their peers on less traditional middle school mathematics content.

Contact:
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www.lrdc.pitt.edu/quasar/quasar.html

Raising the Standard. The New York Regents Exam has spurred thousands more high school students to take and pass college-preparatory mathematics courses. In 1993 then New York Chancellor Ramon Cortines required all students to take tougher Regents-level mathematics and

students to take and pass college-preparatory mathematics courses. In 1993 then New York Chancellor Ramon Cortines required all students to take tougher Regents-level mathematics and science courses traditionally reserved for college-bound students. Beginning in 1995, the state required that all students take Regents-level classes. The number of Hispanic and black students who passed the science portion of the Regents Exam more than doubled over the previous year. The state is now requiring all students take and pass Regents Exams. In addition, Commissioner of Education Richard Mills recently called for an increase in the rigor of the state's requirements for graduation from high school, including adding another year of both mathematics and science to the current two years required in each.

Contact:
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www.nysed.gov

Living Up to Potential. Twenty school districts from Chicago's North Shore joined forces in 1995 to provide their students with a world class education in mathematics and science. Calling themselves the First in the World Consortium, their first challenge was to determine what a "world class" education looked like. They then measured their current performance against that benchmark and developed an improvement strategy.

The Consortium's directed its efforts toward three objectives: (1) benchmarking performance against international standards in mathematics and science, using the Third International Mathematics and Science Study as a guide; (2) creating a forum to clarify world-class education standards for business leaders, policy makers, educators, and community members; and (3) establishing a network of learning communities for educators, parents, and community leaders within the Consortium school districts and beyond.

Students in grades 4, 8, and 12 in First in the World Consortium districts took the TIMSS assessment in Spring 1996. Fourth and eighth graders' results placed them among the top performers in the world, well exceeding U.S. performance generally.

The Consortium attributes its success to the fact that:

- Fifty percent of its 8th grade students took algebra or geometry compared to 25 percent of students nationally who take algebra;
- it had high expectations for students and teachers; and
- it had gained broad-based community support for improved student performance.

The First in the World Consortium is not resting on its success. Its "community of learners" approach continues to promote teacher participation and provide a context for long-term commitment to the consortium's goals and to growth in student learning. To this end, it has created teacher learning networks to strengthen curriculum standards, models of instruction, assessment, and use of technology.

The resources of the First in the World Consortium place it at an advantage. Yet, what truly distinguishes it is its willingness to identify its weaknesses and address them. The consortium credits both state and federal support for helping it focus on its goals. Its experiences demonstrate that, when given the opportunity, U.S. students can perform as well as, or better than, students anywhere.

Contact:
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www.ncrel.org/sdrs/firstwor.htm

Next Steps

Six things educators, policymakers and community members can do:

1. Provide all students the opportunity to take algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in all four years of high school.

2. Build the groundwork for success in algebra by providing a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares students for the transition to algebra.

3. Ensure that all students, parents, teachers, and counselors understand the importance of students' early study of algebra as well as continued study of rigorous mathematics and science in high school.

4. Provide teacher preparation and professional development to teachers of mathematics to increase their knowledge and skills in mathematics and the teaching of mathematics.

5. Support mathematics achievement outside the classroom through math clubs, tutoring, and job shadowing for students who may need extra help.

6. Support parent involvement in their children's mathematics education.

Six things parents can do:

1. Discuss your children's mathematics homework with them.

2. Visit your children's mathematics teacher to find out what your children are learning and how you can help.

3. Insist that your children enroll in algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in high school so they can keep all of their future options open.

4. Ensure that your children are gaining the groundwork for success in algebra through a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares them for the transition to algebra.

5. Help your children understand the importance of taking challenging mathematics and science courses to their future by visiting colleges, familiarizing them with college requirements, and exploring financial aid options available to students.

6. Show the importance of mathematics for career choices by talking with your children about the use of mathematics in your work or the work of adults they know.

Resources

Everson, Howard T. and Marlene Dunham. *"Signs of Success—EQUITY 2000, Preliminary Evidence of Effectiveness."* New York, NY: The College Board, 1996.

Hawes, Mark, Kimmelman, Paul, and Kroeze, David. "Becoming 'First in the World' in Math and Science: Moving High Expectations and Promising Practices to Scale." *Phi Delta Kappan*, Volume 79, Number 1, September 1997.

Jones, Vinetta C. "What A Difference A Standard Makes." In D. Bartels & J. Opert Sandler (Eds.), *This Year in Science: Implementing Science Education Reform.*" Washington, DC: American Association for the Advancement of Science, in press.

Levy, Frank and Richard Murnane. *Teaching the New Basic Skills: Principles for Educating Children to Thrive in a Changing Economy*, New York: The Free Press, 1996.

National Action Council for Minorities in Engineering. *Uninformed Decisions: A Survey of Children and Parents about Math and Science,* Conducted for National Action Council for Minorities in Engineering, By Louis Harris and Associates, 1995.

The National Commission on Teaching and America's Future. *What Matters Most: Teaching for America's Future*, September, 1996. http://www.tc.columbia.edu/~teachcomm/index2.htm

Porter, Andrew. "The Effects of Upgrading Policies on High School Mathematics and Science." Consortium for Policy Research in Education, 1997, and in Brookings Papers on Education Policy, 1997.

Schmidt, William H., McNight, Curtis C., and Raizen, Senta A. *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, East Lansing, MI: U.S. National Center for the Third International Mathematics and Science Study, Michigan State University, 1996. http://kapis.www.wkap.nl/kapis/CIG-BIN/WORLD/book.htm?0-7923-4441-3

U.S. Department of Education. National Center for Education Statistics. *Education and the Economy: An Indicators Report*, Washington, D.C.: U.S. Government Printing Office, 1997. http://nces.ed.gov/pubsearch/infopage.idc?cid=97269XXXXX

U.S. Department of Education. National Center for Education Statistics. *NAEP Facts: Eighth-Grade Algebra Course-Taking and Mathematics Proficiency*, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/pubs/96815.html

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and*

Achievement in International Context, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/timss/

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, Washington, D.C.: U.S. Government Printing Office, 1997. http://nces.ed.gov/timss/

U.S. Department of Education. National Center for Education Statistics. *Statistics in Brief: Changes in Math Proficiency Between 8th and 10th Grades*, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/pubsearch/infopage.idc?cid=93455XXXXX

U.S. Department of Education. Planning and Evaluation Service. *Analysis of NELS:88 Follow-Up Data: Factors That Affect College Enrollment*, Forthcoming.

U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook*, Washington, D.C.: U.S. Government Printing Office, 1997. http://stats.bls.gov:80/ocohome.htm

Appendix

The NELS:88 data. The National Education Longitudinal Study of 1988 (NELS:88) initially surveyed a nationally representative sample of 26,000 public and private school 8th grade students in 1988. The data collected include responses to student questionnaires, scores on standardized achievement tests, high school transcripts, and interviews with parents and teachers. Since the initial survey in 1988, the students have been resurveyed every two years, with the most recent data available gathered two years after their scheduled high school graduation in 1994. The analyses in this report are based on a sub-sample of over 13,000 individuals from whom data were collected in all three follow-up surveys. Analysis of course-taking patterns is based on student reports of 8th-grade course-taking and high school transcript data. The actual titles of mathematics courses as they appear on the transcripts may vary, despite covering similar content (for example, geometric concepts); accordingly, we have attempted to include all courses under the traditional course names (i.e. "geometry," "algebra II") reflective of their content.

Report: Getting Math Early Helps

By LAWRENCE L. KNUTSON
Associated Press Writer

WASHINGTON (AP) Early exposure to serious math, algebra and geometry, opens the gate to college for large numbers of students, including minorities and those from low-income families, an Education Department report says.

The report, "Mathematics Equals Opportunity," was released Monday by Education Secretary Richard Riley, who said it offers evidence that the choice of subjects determines access to college, not whether the school itself is public, private or parochial.

"These courses demand discipline, they demand hard work and they demand responsibility," Riley said as he unveiled the new report in a ceremony at the Old Executive Office Building. "They make a powerful difference in terms of going to college."

The problem, he said, is that only about 25 percent of U.S. eighth-graders enrolled in algebra classes last year.

President Clinton took the report as a new reason to support his proposal for voluntary national tests of reading in the fourth grade and math in the eighth grade "to ensure that all our children meet the high standards of academic excellence they'll need to succeed in tomorrow's world."

Many Republicans oppose such testing, and Clinton said: "I call upon Congress to end the delays. Our children are counting on us."

Riley said that by proposing the tests, Clinton is "laying down a challenge to shake up the status quo."

"If these critics are going to be serious about improving American education, I would urge them to read this report and join us in this call for higher standards," Riley said. "Sometimes you need to put politics aside and get serious about education."

"The voluntary tests will focus like a laser beam on making sure we get the basics right," he said.

The report had three central conclusions:

Eighty-three percent of young people who go on to college take "the important gateway math courses," starting in the eighth grade. Riley said: "That is a very important finding that goes against the conventional wisdom that a family's status and income are the determining factors."

Low-income students who took algebra and geometry were nearly three times as likely to attend college as those who did not. Seventy-one percent of those who took such courses went on to a higher education.

Taking these courses is more important than the type of school attended. The report suggested that students in public and private schools who took rigorous math and science classes were equally likely to score in the highest levels of 12th-grade math tests.

Many Congressional Republicans contend that giving parents tax dollars in the form of vouchers to shift their children out of public schools and into private or parochial schools is the answer to improving their education.

"The report says that there is a much more important choice that is being overlooked entirely and that is the choice of courses," Riley said.

(20 Oct 1997 16:09 EDT)

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10/20/97- Updated 01:27 AM ET

Math cited as key to achievement

WASHINGTON - High school students who take algebra, geometry and other rigorous math courses are much more likely to be successful at college or in the workforce, says a U.S. Education Department report out Monday.

Students with a grasp of higher level math achieve regardless of family income or public or private schooling, says Education Secretary Richard Riley.

Riley will release the "white paper" at a White House ceremony Monday. He'll stress that math may be a great equalizer.

The proportion of students who take algebra I and geometry who head to college:

- ☐ 83% of all students.
- ☐ 71% of low-income.
- ☐ 94% of high-income.
- ☐ 84% of middle-income.

Conversely, only 36% of those not taking algebra I and geometry went to college. And the attendance gap is wider among income groups in this category: 27% of low-income students, 60% of high-income and 44% of middle-income.

Students headed for the workforce with a solid math background earned, on average, 38% more per hour than peers without it.

Yet while algebra is the "gateway" to advanced math and science in high school, most students do not take it in middle school, Riley says.

He cites a 1996 report by the National Assessment of Educational Progress showing that only 25% of U.S. eighth-graders enrolled in algebra, and that low-income and minority students were even less likely to take it. Japan and Germany offer much more advanced math at an earlier grade.

The release of the findings comes as the administration gears up for tough education battles. At issue are different House and Senate bills on voluntary national tests, allowing poor students to use tax-supported vouchers to attend private schools and creating "Education IRAs" to pay for private and parochial schools.

By Tamara Henry, USA TODAY

- ☐ Go to Lifeline
- ☐ Go to People news
- ☐ Go to Life front page

** changes in italics as of 3:00 pm, October 17th*

U.S. Department of Education
"Mathematics Equals Opportunity"
Agenda

#450 Old Executive Office Building
October 20, 1997

NOT FOR RELEASE

12:00pm

I. Secretary Richard Riley
- Announces the release of report
- "Taking tough courses are important for going to college"
- High, rigorous national standards are important
- *introduces the Superintendent*

12:10pm

II. Superintendent Jerome Clark
- Former need in district to improve math
- What is Equity 2000?
- Changes in the district
- Results from Equity 2000
- *introduces the teacher*

12:15pm

III. P.G. County Teacher, Bernadette Dantley
- Classroom experiences with Equity 2000
- *introduces the students and the Secretary's discussion*

12:20pm

IV. Secretary Riley and Prince George's County students
- *Interactive discussion with the Secretary on their personal experiences with tough math courses, planning for the future*

12:30pm END

V. Few minutes of one-on-one press availability with participants

Contact: Erica Lepping (202)401-2571, Office of Public Affairs

Math Report 10/97

SUNTUM_M @ A1
10/20/97 09:53:00 AM

Record Type: Record

To: William R. Kincaid, Joshua Silverman

cc:
Subject: Radio actuality by the President

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release October 20, 1997

RADIO ACTUALITY OF THE PRESIDENT

THE PRESIDENT: A new study released by the Department of Education today confirms what most of us knew instinctively already -- students, especially low income students, who challenge themselves with rigorous math and science courses in high school are much more likely to go on to college.

I've worked hard to make college affordable for all Americans. Our increased Pell Grants and work study positions, the new Hope Scholarship tax credits for the first two years of college and other tax credits in education IRAs for the remaining years, graduate school and other training -- all these will truly open the doors of college to all who are willing to work for it.

We've addressed the economic barriers, now we have to tackle the academic ones. While the studies show that taking algebra in middle school was essential to preparing for advanced math and science classes, just 25 percent of our 8th graders took algebra in 1996. We must do better. That's why I call upon all Americans to support our voluntary national tests for 4th grade reading and 8th grade math, to ensure that all our children meet the high standards of academic excellence they'll need to succeed in tomorrow's world. Our math test will make sure our children master algebra and prepare for math and science courses that lead to college.

I call upon Congress to end the delays. Our children are counting on us.

UNITED STATES
DEPARTMENT OF EDUCATION NEWS

ADVISORY **ADVISORY** **ADVISORY**

WHO: U.S. Secretary of Education Richard W. Riley
Prince George's County Public Schools Superintendent Jerome Clark
Equity 2000 Director Vinetta Jones
Suitland High School Mathematics Teacher Bernadette Dantley
Prince George's County students

WHAT: Will participate in a press conference announcing the release of white paper, "Mathematics Equals Opportunity"

WHEN : Monday, October 20, 1997
12:00 pm

WHERE: # 450 Old Executive Office Building
17th and G Streets, NW
Washington, D.C.

Secretary Riley will deliver highlights from the report "Mathematics Equals Opportunity" which provides information on the link between taking tough math courses early, such as algebra and geometry, and going on to college and succeeding in the job market. The secretary will emphasize the importance of achieving to high standards and remark on the new financial opportunities students have to attend college. Prince George's County students and a teacher involved in Equity 2000 will also join the secretary in a discussion about the importance of taking tough math courses and preparing for college.

For security clearance into the event, please call Erica Lepping at (202)401-2571 and leave the spelling of your full name, social security number and date-of-birth. **You should plan to be at the Old Executive Office Building no later than 11:30am,** in light of the clearance process.

CONTACT: Erica Lepping (202) 401-2571, Pager 1-800-SKY-GRAM, pin# 211-9840

# # #

PRESIDENT WILLIAM J. CLINTON

RADIO ACTUALITY

OCTOBER 17, 1997

A new study released by the Department of Education today confirms what many of us knew instinctively. Students -- especially low-income students -- who challenge themselves with rigorous math and science courses in high school are much more likely to go on to college.

I have worked hard to make college affordable for all Americans. Our increased Pell Grants and work study positions, the new HOPE Scholarships and other tax credits will truly open the doors of college to all who are willing to work for it.

We have addressed the economic barriers. Now we must tackle the academic ones. While the study showed that taking algebra in middle school was essential to preparing for advanced math and science classes, just 25 percent of eighth graders took algebra in 1996. We must do better. That is why I call upon all Americans to support voluntary national tests in fourth grade reading and eighth grade math to ensure that all children meet high standards of academic excellence. Our math test will make sure our children master algebra and prepare for the math and science courses that lead to college. I call upon Congress to end the delays. Our children are counting on us.

DRAFT

Statement of
Richard W. Riley
U.S. Secretary of Education

Briefing for White House Reporters
October 20, 1997

Good afternoon. I have just returned from traveling with the President to Brazil. Some of you were down there as well. I am here today to release a major report and brief you on the week ahead on the President's education agenda. This is a very busy week for the President and the Vice-President when it comes to education.

The President, as you know, used his Saturday radio address to praise a bipartisan effort to support charter school legislation that is now moving through the Congress. He also used the radio address to endorse another bipartisan legislative initiative that is being led by Congressman John Porter and Congressman David Obey to fixing failing schools.

This is a very important initiative because it would support proven models of success that are helping to turn around failing schools all across the country. Some of these models are being used this year for the first time here in the District of Columbia. We need to remember, as the President so often says, that for every problem in American education there is already a solution and part of our job is to make the match. We know how to fix failing schools and the Porter-Obey initiative is targeted funding to help us get the job done.

Today, we are releasing a major report entitled *Mathematics Equals Opportunity* that conveys three powerful messages. First, that young people who go on to college by overwhelming numbers -- 83 percent -- take the tough math courses like algebra I and geometry.

Second, that taking these gate-keeping courses is especially important for low-income students. Seventy-one percent of low income students who took algebra I and geometry went on to college compared to only 27 percent of low-income students who did not take these courses.

I just met with a group of young people from Prince George's County who are part of the College Board sponsored Equity 2000 initiative to get more young people to take algebra. These young people have gotten the message that getting ready for college is their responsibility and that means taking the tough math courses. But we need to make sure that everyone gets that message. Only 63 percent of all young people take algebra and geometry and only 43 percent of all low-income students takes these math courses.

The third message of this report is that taking the right courses is more important than what type of school you attend, whether it is public or private. This latter point deserves some attention. Many vouchers proponents argue that giving parents public tax dollars to send their children to private schools is the key to educational renewal.

This reports says that there is a much more important choice that is being overlooked entirely and that is the choice of courses. Taking the right courses matters a lot more in terms of going to college than whether your school is public, private or parochial.

The President worked very hard to create the Hope Scholarship and the Lifetime Learning Tax credit so young people have the financial support they need to go to college. But young people have a responsibility as well to get ready academically. This report tells them why it is so important.

Now, let me go on and tell you about the rest of the week.

Tomorrow, the President will meet with college and university leaders who have endorsed his *American Reads Challenge*. Making sure that every child in America can read well by the end of the third grade is a national goal that we can achieve with the help of thousands of energetic college students who have signed up to be reading tutors.

But we also want the Congress to act on the President's request for legislation. I am concerned that the House is starting to get stuck in the usual partisan rut and losing sight of what is important. It's a sad day when a reading initiative has become a political hostage which seems to be the thinking of some members of Congress.

Making sure that all of our young people are literate is a grand goal that has the full support of the American people. Congress needs to fulfill its part of the bargain. Let's remember that the reading initiative is part of the budget deal.

For his part, Vice-President Gore will be visiting Louisiana State University and give a major address on race and education at Southern University Law Center.

On Wednesday *(not confirmed yet)* the President and the Vice President will meet with a group of high tech business leaders who strongly support the President's call for voluntary national tests in reading and math.

On Wednesday
~~Later on during the day,~~ I will join Larry Summers, the Deputy Secretary at Treasury, at a press conference with Rep. Charlie Rangel (*and Cong. Dick Gephardt?)* to once again reaffirm the Administration's strong opposition to the Coverdell IRA education proposal.

The Coverdell proposal is bad tax policy, a budget buster and it has little if anything to do with improving public education. The Administration supports the Rangel alternative which has a much more targeted focus and helps us deal with the problem of school overcrowding.

On Thursday, the President, the Vice-President, the First Lady and several members of the Cabinet including Donna Shalala and myself will participate in the White House Child Care Conference.

On Friday, both the President and the Vice-President will focus in on education. The President will meet with several hundred teachers who are part of the effort surrounding the National Board for Professional Teaching Standards. This is a Initiative led by Governor Jim Hunt to establish nationally accepted credentials for excellence in teaching. There are only 500 teachers in America who have now met these high standards. The President's goal is to have 100,000 board-certified teachers in the next ten years.

For his part, Vice-President Gore will announce a new public-private partnership to match computers donations to low-income schools from federal agencies.

This is a very busy week for the Administration when it comes to education and that's the way it should be. Education is President Clinton's number one priority and we need to pick up the pace to get all of America's children ready for the 21st century. Parents all over America are tuned into education as never before. We need to take their concerns seriously and that is one thing that the President is doing. Education matters and the President is determined to get things done. Now, I will be happy to answer any of your questions.

Daily Education News

Friday, October 17, 1997

1. Forbes

October 20, 1997

American schoolkids score relatively well through fourth grade. Why do they lag so badly in subsequent years?

Claiming credit where no credit is due

By Peter Brimelow

BILL CLINTON GOT A LOT OF PUBLICITY this summer when he claimed credit for American fourth-graders' second-place ranking in science, as measured by the **Third International Mathematics and Science Study (TIMSS).** The previous year, American eighth-graders came in seventeenth.

"There are a lot of people who never believed that U.S. children would score in the top two in the world on any of these tests," Mr. Clinton reportedly said. "Now they know they were wrong."

Bunk, says Barbara Lerner of Chicago-based Lerner Associates, public policy consultants. American fourth-graders have always done about this well on international tests, Lerner points out. Where they do badly is where it really matters—as 17-year-olds—at the end of the K-12 educational process.

"Older students resist," Lerner says. And American educators apparently don't want to oppress them. Somewhere between the fourth grade and graduation, American students tend to fall behind.

According to NAEP, the National Assessment of Educational Progress U.S. 17-year-olds score about the same or slightly below the levels of knowledge in science, math and reading achieved nearly 30 years ago. Recently, scores have basically been moving sideways.

The NAEP scores do represent a rebound from the 1970s, when achievement levels were falling sharply—a dark episode in American education history that has been called "The Great Decline."

"But NAEP only began gathering data when the decline was well under way," says Lerner. "So today's 17-year-olds are still probably below the levels of the early 1960s."

Minority scores in some areas have actually rebounded better than white scores. But they still lag significantly. And there have been some recent retreats.

The lack of real progress comes in spite of the huge sums that the educational establishment has been extracting from the American taxpayer. The U.S. spends a higher proportion of its GDP on K-12 education than the Organization for Economic Cooperation and Development (OECD) average and many industrialized countries (see chart, upper left). (We threw in Korea because it and Japan tied for first place in the recent TIMSS study.)

And because the U.S. economy is so much larger, this translates into a massive excess of per-pupil spending. Conversely, Korea's per-pupil spending is at a strikingly low level.

To some extent, higher per-pupil spending is inevitable in the industrialized world because higher living standards bid up higher labor costs. But most industries compensate with higher productivity.

And it's not just the amount of U.S. education spending but the distribution that is extraordinary (see chart, lower left). For example, the Germans spend almost as much per pupil on early childhood and secondary education. But neither they nor the Koreans put anything like the same resources into college students. Do Americans go to college to learn what Germans and Koreans are taught earlier?■

1. San Diego Union-Tribune

October 17, 1997

More math urged at 8th-grade level

By Sharon L. Jones
STAFF WRITER

America's middle-school mathematics courses are intellectual wastelands, an expert said yesterday as he urged educators to join a national effort to have all eighth-graders study algebra and geometry.

According to an international study of mathematics and science, students around the world generally are introduced to eight new topics between fifth and eighth grade, said researcher William Schmidt.

In the United States, however, students study generally the same things they studied in elementary school, such as addition, subtraction, multiplication and division, he said.

No wonder they grow bored and lose motivation to take advanced mathematics classes, said Schmidt.

"We simply have a conception of basic that is static, flat, dormant at the fourth-grade level," said Schmidt, while speaking at a conference organized by the **U.S. Department of Education.**

About 1,600 people have registered to participate in the 1997 Regional Conference on Improving America's Schools, which runs through tomorrow at the Town and Country Convention Center in Mission Valley.

The conference is titled "A call to action: Working together for equity and excellence." It is being broadcast on the World Wide Web at the following address: http://www.iaswebcast.org/.

Yesterday's opening session featured a roundtable discussion of five assistant secretaries of education.

In videotaped remarks, President Clinton stressed the importance of setting voluntary national standards of academic excellence and national tests to measure whether students are meeting the standards.

"Our children will grow according to the expectations we have of them, so let's all work together to raise those expectations, to strengthen and improve all our schools, and to help all our children reap the promise of the 21st century," Clinton said.

Clinton wants national tests to measure students' reading skills at the end of fourth grade and to measure their math skills at the end of eighth grade.

House Republicans say such a test would duplicate the work of existing standardized tests.

In a session on standards and accountability, Gerald Tirozzi, assistant secretary in the office of elementary and secondary education, said testing is key to holding the nation's schools accountable for student performance.

He said a school accountability system starts with academic standards that define what students should know and be able to do at each grade level. Instructional materials and teacher training should support those standards, and tests should measure whether students are meeting the standards, he said.

Tirozzi said educators agree that students should be able to read for comprehension by the end of fourth grade and perform algebraic equations by the end of eighth grade. Students who haven't mastered these skills at these grade levels generally never catch up to their peers and attend college at much lower rates, he said.

Tirozzi said many educators are uncomfortable with the idea of holding schools accountable for student performance, but the public is frustrated by the lack of accountability.

If educators don't respond by making themselves accountable, there will be more retired military officers running school systems, educational vouchers for private education, and privatization of schools, he said.

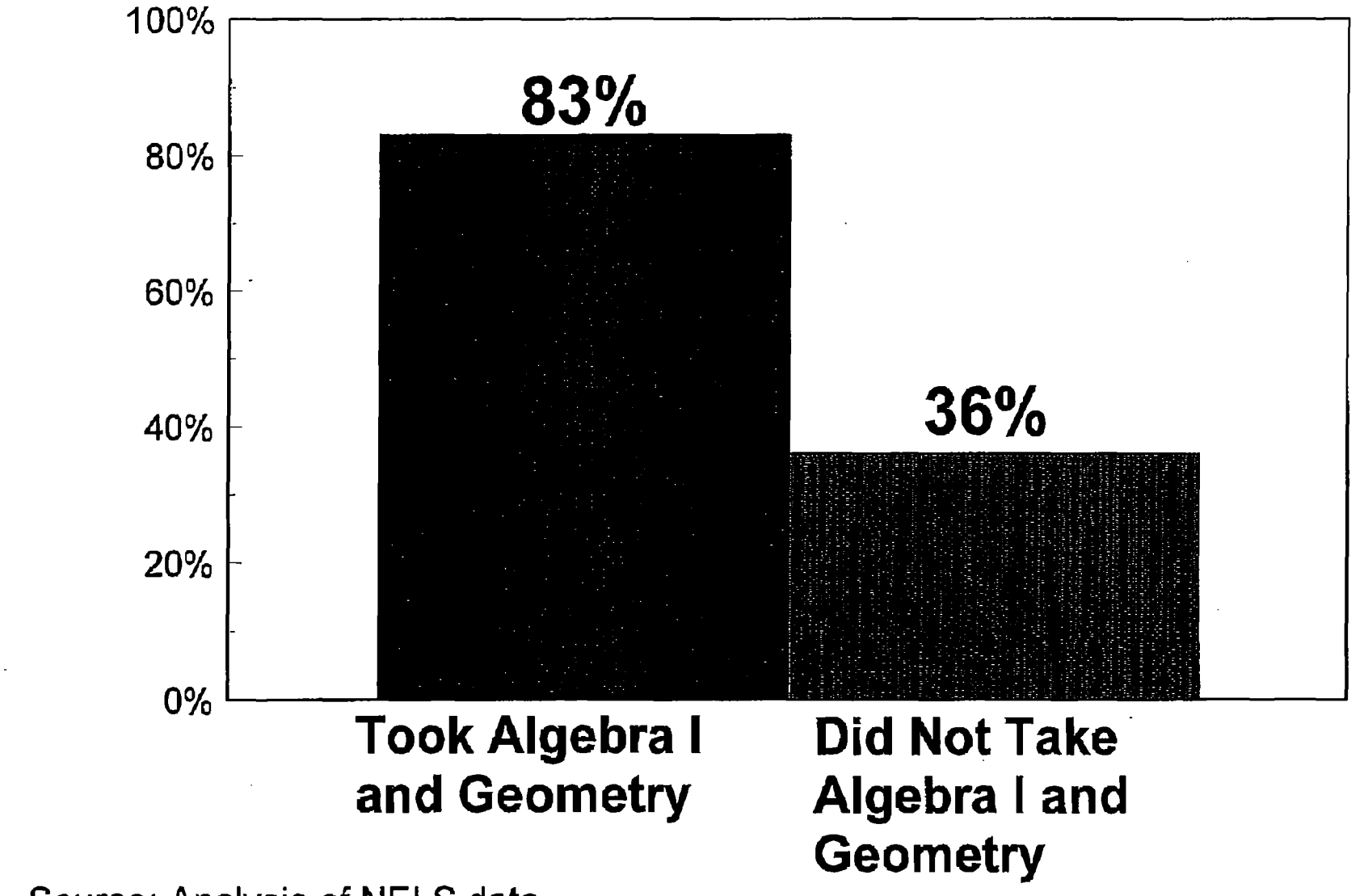
"People are looking for different ways to improve our schools," he said.

In a session on mathematics, Schmidt explained the results of the Third International Mathematics and Science Study. U.S. students scored about the international average in fourth grade, but below the international average in eighth grade.

American eighth-graders outperformed only seven countries in mathematics.

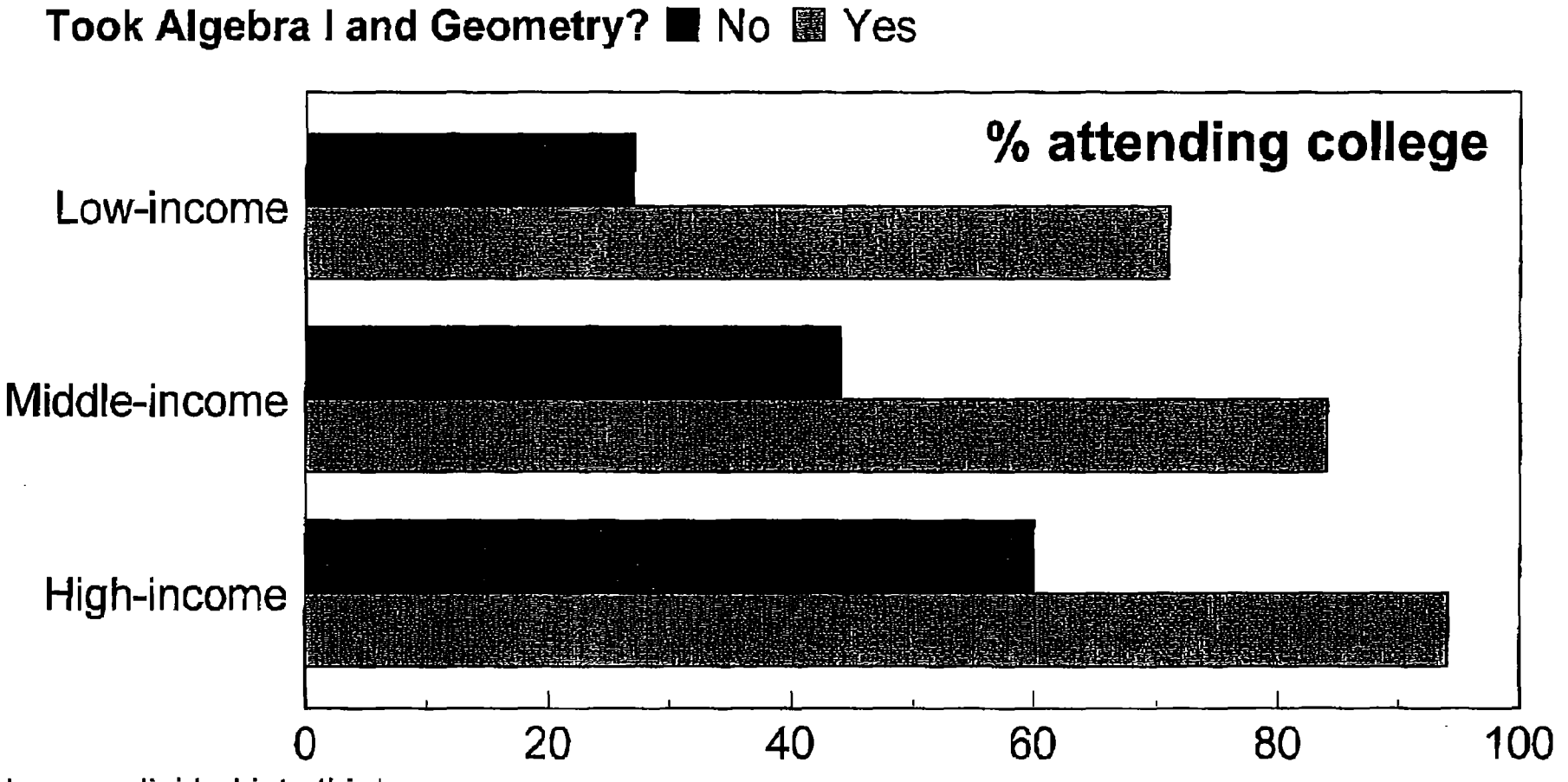
Schmidt said the United States must radically change the way it is teaching mathematics, or it won't have a work force that is able to compete. "This global society isn't rhetoric anymore; it's reality," he said.■

Figure 1
College Attendance by Course-Taking



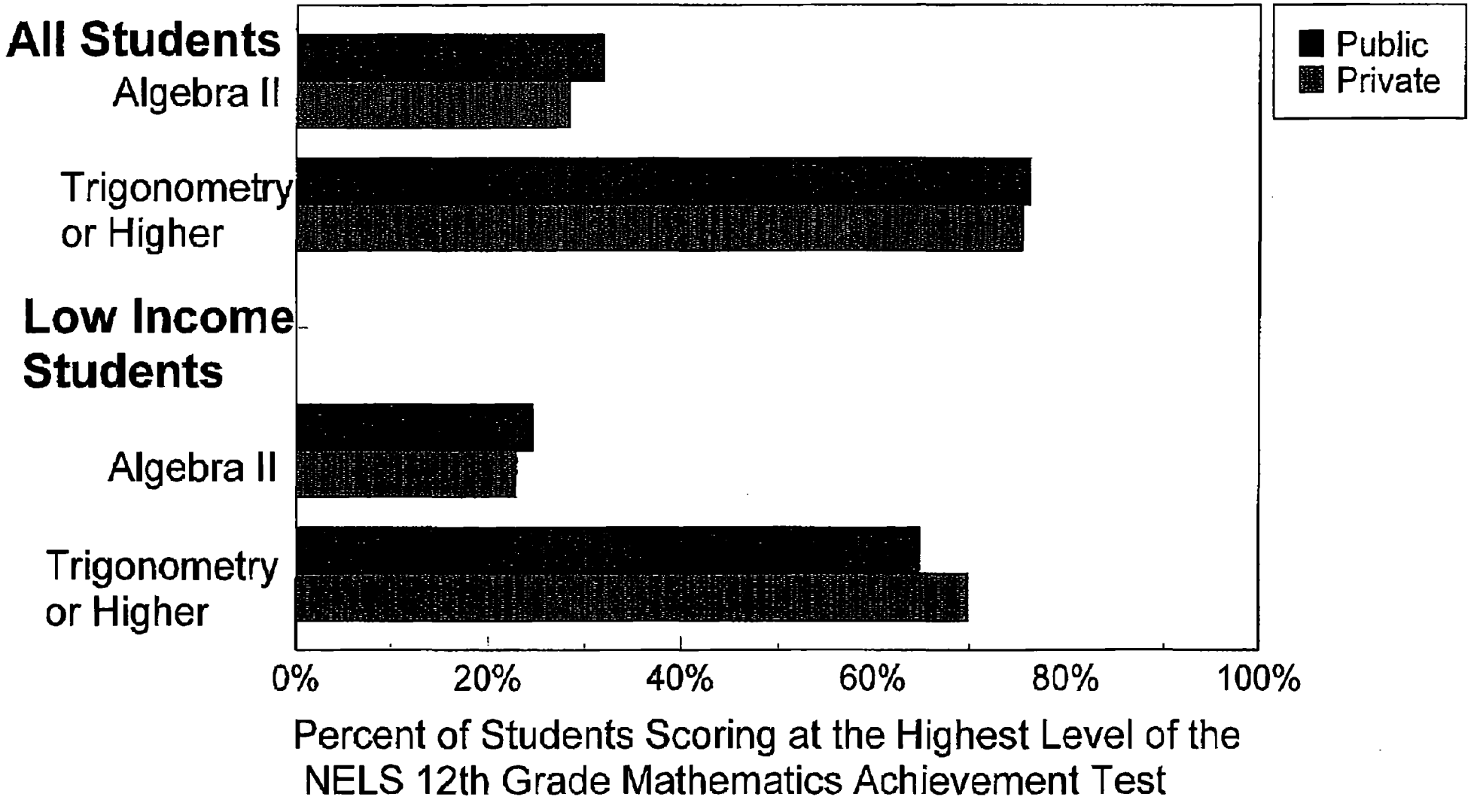
Source: Analysis of NELS data

Figure 2
College Attendance by Income and Course-Taking



Income divided into thirds
Source: Analysis of NELS data

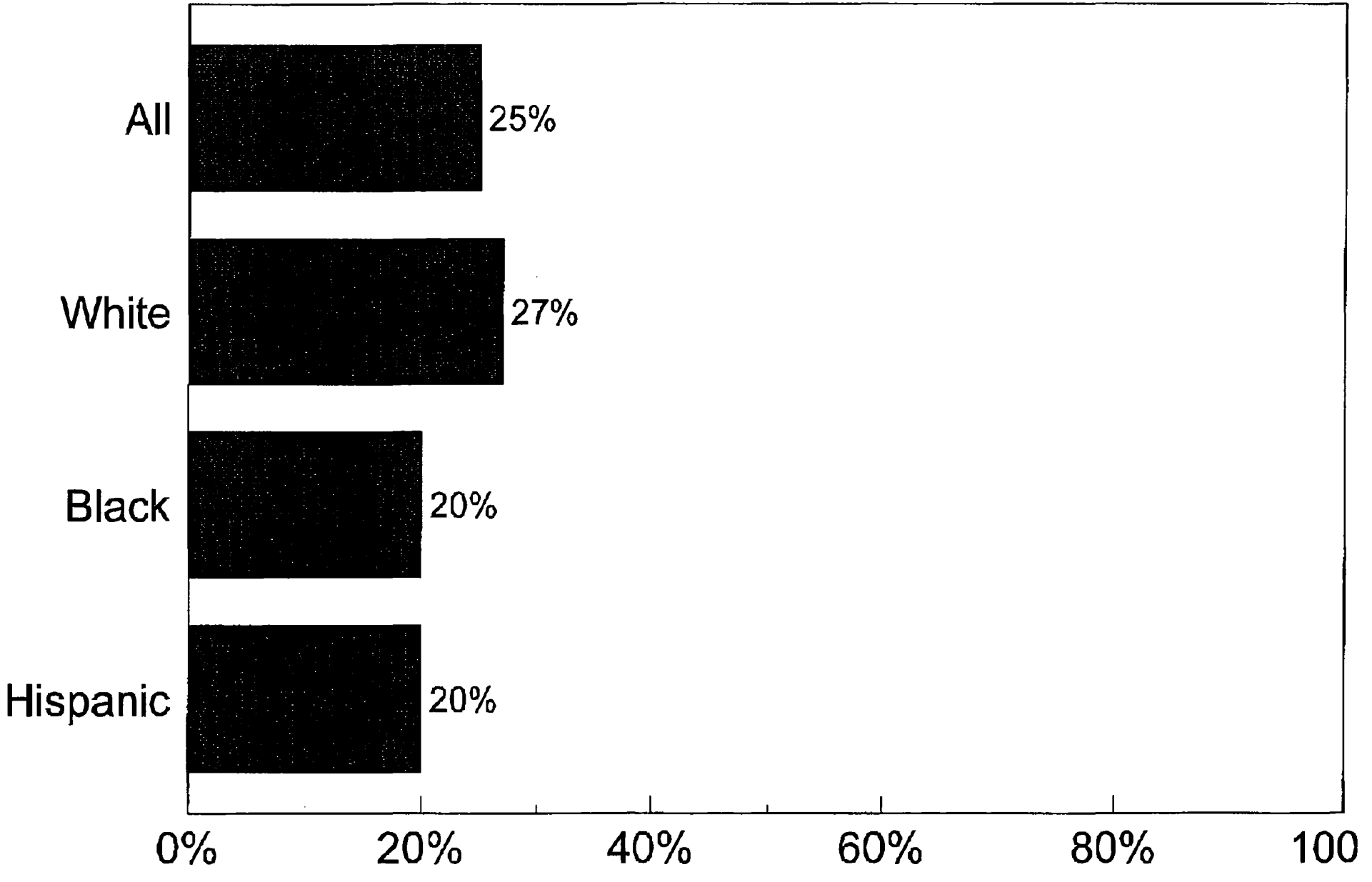
Figure 3
Mathematics Achievement by Highest Mathematics Course Taken



Achievement divided into thirds; Students in highest level scored in the top third

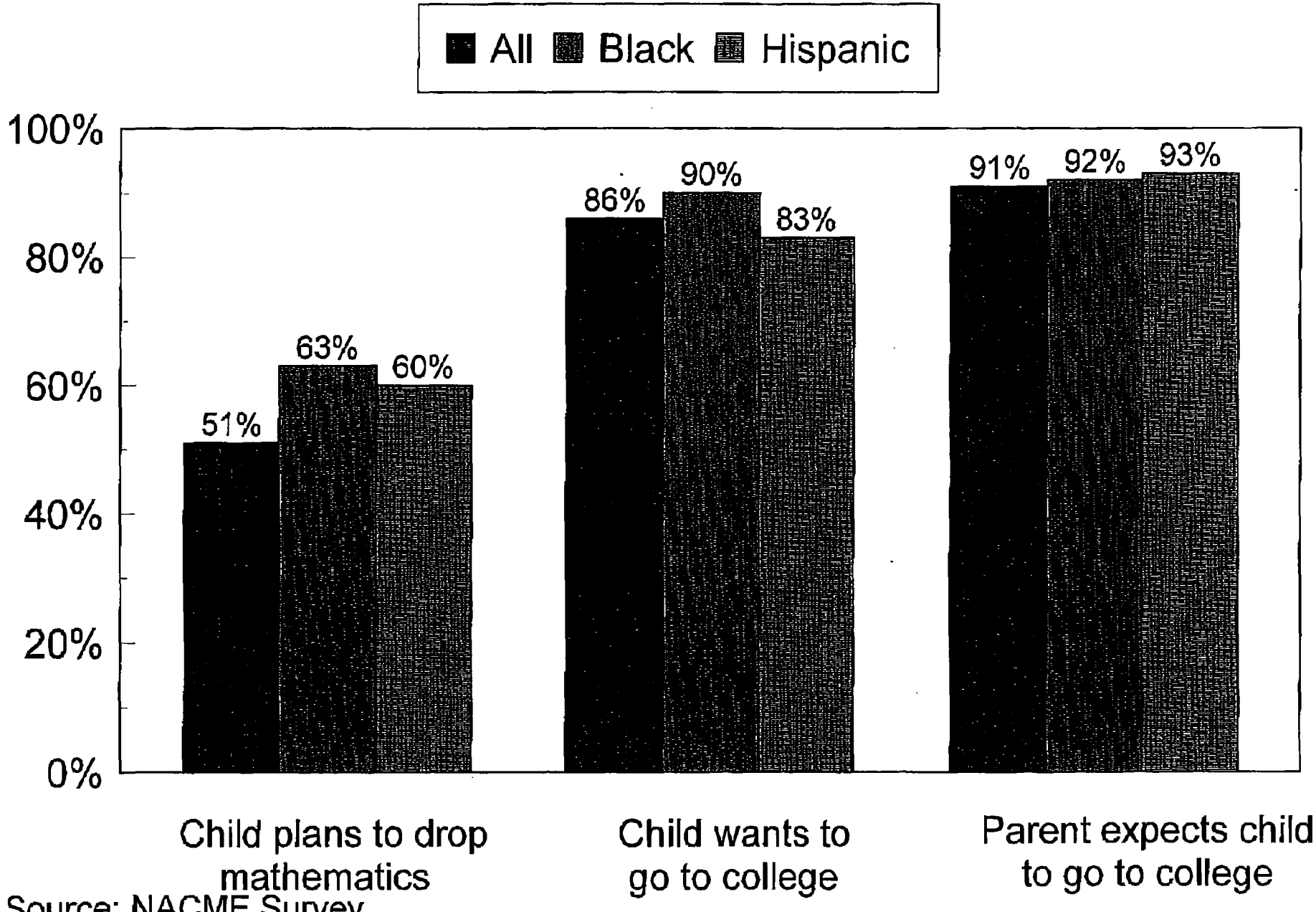
Source: Analysis of NELS data

Figure 4
Proportion of Eighth-Graders Enrolled in Algebra, 1996



Source: 1996 NAEP Mathematics Assessment background questionnaire

Figure 5
Students Plan to Drop Mathematics, But Want to Go to College



Source: NACME Survey

10/16/97

U.S. Department of Education
Office of Under Secretary, Planning and Evaluation Service
600 Independence Avenue, SW
Room 4168, FOB10
Washington, DC 20202

FAX COVER SHEET

Fax Number: (202) 401-3036

TO : Bill Kincaid

FAX NO.: 456-7028

(Number of pages, including cover sheet: 3~~6~~ 5)

FROM: Melissa Chabran

PHONE NO.:401-1265

Message:

Bill,

Attached is the most recent version of the mathematics brief entitled, "Mathematics Equals Opportunity."

Melissa Melissa

MATHEMATICS EQUALS OPPORTUNITY

Information brief prepared for
U. S. Secretary of Education Richard W. Riley
for speech at the White House, Washington, D.C.

October 20, 1997

A Letter from the Secretary of Education

Many parents, students, and educators in the United States are beginning to understand that mastering mathematics is a gateway to college. The key to the "gate" is taking algebra or courses covering algebraic concepts by the end of the 8th grade. However, many 8th and 9th graders may be behind in their course taking to get on the road to college.

Recent analyses by the U.S. Department of Education indicate that high school students who take algebra, geometry, and other rigorous mathematics courses are more likely to go on to college. This is true regardless of their family income. In fact, the benefit of taking rigorous courses is greatest for students from low-income families. Students who take chemistry, a subject that requires a firm grasp of mathematics, are also more likely to go to college. Other research tells us that the advantages of a solid mathematics background are not limited to the college bound. Workers who have mastered mathematics earn more and are less likely to be unemployed than workers who are less proficient in mathematics.

However, not all students have access to rigorous mathematics courses -- either because their school does not offer everyone a full selection of challenging courses, or because not all students are prepared for and encouraged to take them. The results of the recent Third International Mathematics and Science Study (TIMSS) confirm that many students enter high school without a solid grounding in mathematics, closing doors very early for further education and better careers.

The implication is clear: The 8th grade is a critical point in mathematics education. Achievement at that stage gives students a leg up on taking rigorous high school mathematics and science courses important for later success.

As a nation, we must ensure that all our students develop the mathematics foundation they need by the end of the 8th grade--and then build on it throughout high school. We challenge parents, schools, community groups, higher education, and employers to ensure that all children have access to rigorous mathematics courses and a chance at college. The U.S. Department of Education stands ready to assist them by providing financial aid to college students and supplementing Advanced Placement Exam fees for students who demonstrate need. Additionally, the Department provides funding through Title I and other programs of the Elementary and Secondary Education Act (ESEA) to assist schools in upgrading mathematics teaching and learning nationwide. It is also offering a voluntary national test in 8th grade mathematics, so that parents and schools can benchmark their students' performance. Together, we will help to ensure that all students are given the opportunity to excel.

Sincerely,

Richard W. Riley

Table of Contents

Executive Summary

In the United States today, mastering mathematics has become more important than ever. Students with a strong grasp of mathematics have an advantage in academics and in the job market. The 8th grade is a critical point in mathematics education. Achievement at that stage clears the way for students to take rigorous high school mathematics and science courses—keys to college entrance and success in the labor force. However, most 8th and 9th graders lag so far behind in their course taking that getting on the road to college is a long way off.

This report highlights the following findings:

- **Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not.** Data from the National Educational Longitudinal Study (NELS) reveal that 83 percent of students who took algebra I and geometry went on to college within two years of their scheduled high school graduation. Only 36 percent of students who did not take algebra I and geometry courses went to college. While nearly 89 percent of students who took chemistry in high school went to college, only 43 percent of students who did not take chemistry went to college.

- **Algebra is the "gateway" to advanced mathematics and science in high school, yet most students do not take it in middle school.** Students who study algebra in middle school and who plan to take advanced mathematics and science courses in high school have an advantage: approximately 60 percent of the students who took calculus in high school had taken algebra in the 8th grade. However, 1996 NAEP data reveal that only 25 percent of U.S. 8th graders enrolled in algebra, and that low-income and minority students were even less likely to take algebra in the 8th grade.

- **Taking rigorous mathematics and science courses in high school appears to be especially important for low-income students.** Low-income students who took algebra I and geometry were almost three times as likely to attend college as those who did not. While 71 percent of those who took algebra I and geometry went to college, only 27 percent who did not take those courses went on to college. By way of comparison, 94 percent of students from high-income families, and 84 percent of students from middle-income families who took algebra I and geometry in high school went on to college. Sixty percent of students from high-income families and 44 percent of students from middle-income families who did not take algebra I and geometry went to college.

- **Despite the importance of low-income students taking rigorous mathematics and science courses, these students are less likely to take them.** Students from higher-income families are almost twice as likely as lower-income students to take algebra in middle school and geometry in high school. They are more than twice as likely to take chemistry.

Other important findings include:

- **Mathematics achievement depends on the courses a student takes, not the type of school the student attends.** Students in public and private schools who took the same rigorous mathematics courses were equally likely to score at the highest level on the NELS 12th grade mathematics achievement test.

- **Students whose parents are involved in their school work are more likely to take challenging mathematics courses early.** Students whose parents were involved in their education were more likely to take courses like algebra and geometry in the 8th and 9th grade than students whose parents were not involved.

- **The results of the Third International Mathematics and Science Study (TIMSS) reveal that the middle school mathematics curriculum may be a weak link in the U.S. education system.** While U.S. 4th graders scored above the international average in mathematics and science, U.S. 8th graders scored below average in mathematics, and only slightly above the international average in science. Initial analysis of TIMSS data also shows that the middle school mathematics curriculum in the U.S. is less challenging than in other countries. The curriculum of average 8th-grade mathematics classrooms in the U.S. resembles 7th grade curriculum elsewhere. Although algebra and geometry are integral elements of the middle school curriculum in other countries, only a small fraction of U.S. middle schools offer their students these topics.

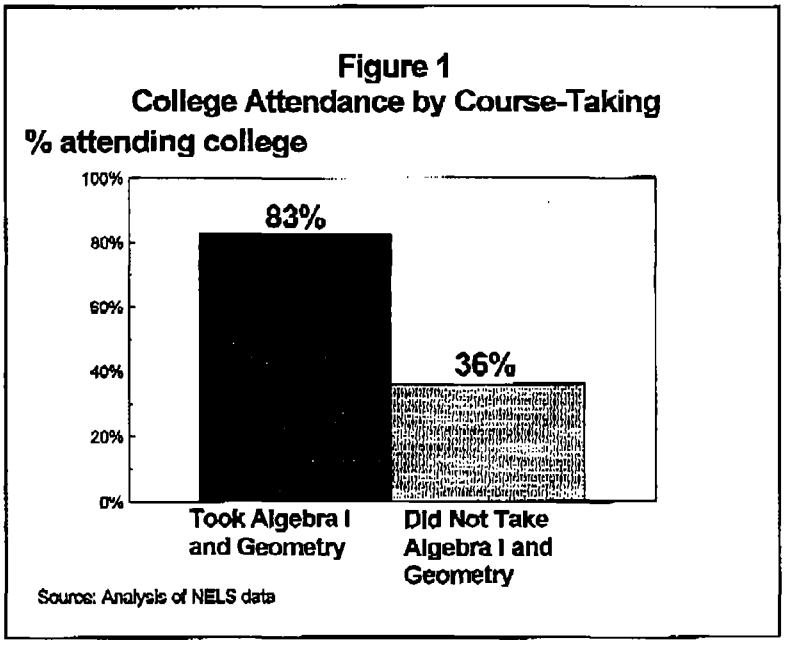
Algebra in the Curriculum

Making a successful transition from arithmetic to more advanced mathematics, including algebra and geometry, has often been difficult for students. As a result, many mathematics programs in the U.S. are now systematically incorporating some fundamentals of algebra and geometry into the upper elementary grade curriculum. In these programs, 5th, 6th and 7th grade students are representing and solving equations, characterizing patterns and rates of change among variables, and using other fundamental algebraic concepts.

In addition, some middle and high schools are taking a new approach to advanced topics. While many schools offer the traditional model of separate courses for pre-Algebra, Algebra I, Geometry, Algebra II, Trigonometry, pre-Calculus and Calculus, these schools are integrating them. This approach is consistent with practices in other industrialized nations, which integrate algebra, geometry, and other topics throughout the elementary, middle, and high school years and offer a significant component of algebra in the 8th grade. Building a firm foundation in algebra during the elementary and middle school years eases the shift from arithmetic to advanced topics, whatever the format of students' new curriculum. NELS and NAEP, the two sources of national mathematics course-taking data analyzed in this brief, employ traditional courses titles, such as "algebra I" and "geometry." Thus, these titles are used throughout the brief.

Mathematics and Future Opportunities

The Importance of Mathematics for College Entrance



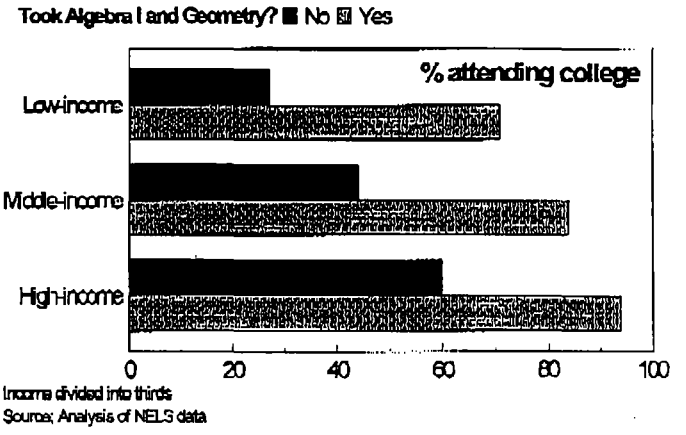
Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not. Data from a longitudinal survey of students who were in the 8th grade in 1988 (National Educational Longitudinal Study or NELS) reveal that 83 percent of students who took algebra I and geometry enrolled in college[1] within two years of their scheduled high school graduation. Only 36 percent of students who did not take algebra I and geometry went to college (Figure 1). Similarly, students who take rigorous science courses in high school are much more likely to go to college. While nearly 89 percent of students who took chemistry entered college, only 43 percent who did not take chemistry went to college.

Students who take more rigorous mathematics courses also show higher gains in mathematics achievement (measured by the mathematics achievement test given as part of NELS) than students who take less challenging courses, even when controlling for achievement. For example, among students who initially began at the same level of mathematics proficiency in the 8th grade, students who had taken algebra II or geometry by the 10th grade experienced greater gains, on average, than students who had taken no algebra or only algebra I during that period.

[1]Throughout this report, the term "college" is used to refer to any postsecondary education taken at a public, private not-for-profit, or private for-profit institution.

Students of all income levels who take rigorous mathematics and science courses in high school are more likely to go to college, and among low-income students (students in the bottom third of the income distribution)[2], the difference is particularly dramatic. Students from low-income families who took algebra I and geometry were almost three times as likely to attend college as those who did not. While 71 percent of low-income students who took algebra I and geometry went to college, only 27 percent of low-income students who did not take algebra I and geometry went on to college. The differences are also dramatic among students from middle- and high-income families: 94 percent of students from high-income families, and 84 percent of students from middle-income families who took algebra I and geometry went on to college, while 60 percent of students from high-income families and 44 percent of students from middle-income families who did not take geometry still went on to college (Figure 2).

Figure 2
College Attendance by Income and Course-Taking



Unfortunately, many students, in particular low-income students, do not take these rigorous mathematics and science courses. According to NELS, 63 percent of all students took algebra I and geometry and 50 percent took chemistry. Students from low-income families, however, were far less likely than their more advantaged peers to take these rigorous courses. Among students in the bottom third of the income distribution, 46 percent took algebra I and geometry and only 33 percent took chemistry. By way of comparison, fully 81 percent of students in the top third of the income distribution took algebra I and geometry, and 72 percent took chemistry. The differences are similar for other rigorous mathematics courses (Table 1).

[2]Income data are based on total family income reported by parents. Low, middle, and high income groups each contain approximately one-third of the sample. The "all" category includes additional observations with missing income data.

Table 1: Course-Taking Patterns of NELS Students

	Percent of Students Taking Course			
	All	Bottom Income	Middle Income	Top Income
Algebra I and Geometry	**63**	**46**	**68**	**81**
Trigonometry	18	10	19	30
Chemistry	50	33	52	72

Accounting for course-taking patterns dramatically reduces the difference in the rate of college-going between low- and high-income students. Students from high-income families are almost twice as likely to attend college as students from low-income families (86 percent compared to 44 percent) when course-taking patterns are not accounted for. However, comparing only students who have taken rigorous courses to one another, students from low-income families go to college at rates much more similar to students from middle- and high-income families (Table 2). For example, among students who took chemistry in high school, 95 percent of high-income students, 89 percent of middle-income students, and 79 percent of low-income students went to college. When low-income students take rigorous courses, income effects on college entrance rates diminish greatly, although they do not disappear.

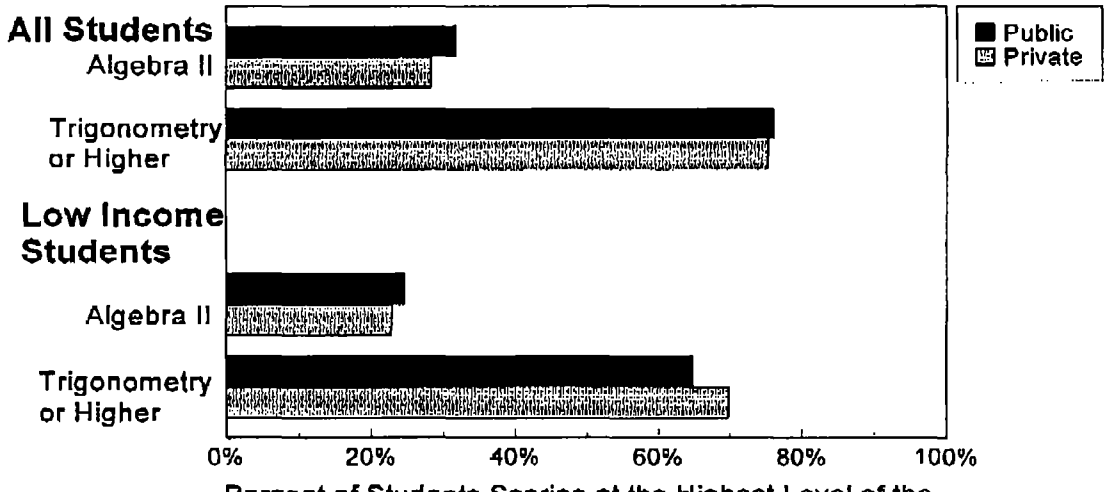
Table 2: College Attendance by High School Course-Taking Patterns of NELS Students

	Percent of Students Attending Postsecondary Education				
		All	Bottom Income	Middle Income	Top Income
	All	63	44	69	86
Algebra I and Geometry	**Yes**	**83**	**71**	**84**	**94**
	No	**36**	**27**	**44**	**60**
Trigonometry	Yes	94	90	92	98
	No	59	42	66	83
Chemistry	Yes	89	79	89	95
	No	43	31	50	68

Public Versus Private Achievement Depends on Course-Taking, Not the Type of School

In general, the mathematics courses students take in high school determine achievement more than the type of school they attend. A great deal of diversity exists in public and private schools. It is useful to note that accounting for course-taking patterns makes the mathematics achievement of students in both types of schools very similar. Public and private school students who took the same mathematics courses were almost equally likely to score at the highest level on the NELS 12th grade mathematics achievement test. This was also true for low-income public and private school students. Additionally, among both public and private school students of all incomes, students who had taken more rigorous mathematics courses were much more likely to score at the highest achievement level (Figure 3).

Figure 3
Mathematics Achievement by Highest Mathematics Course Taken



Achievement divided into thirds; Students in highest level scored in the top third
Source: Analysis of NELS data

[1] Private schools include non-religious, Catholic, and other private schools.

Mathematics in College, the Workplace, and the 21st Century

The benefits of taking rigorous mathematics and science courses extend to students heading into the job market and to both two- and four-year colleges. As technology becomes prevalent in the workplace, more and more workers will find they need to do high levels of mathematics and science. The backgrounds they will need for doing this will have begun to form even before high school. Rigorous mathematics and science preparation is also important to students intending to go to a two- or four-year college or university. The level and number of mathematics courses that a student needs to take before and during college depend on the college and the major that the student wants to pursue. Mathematics- and science-related disciplines typically require that students have taken rigorous mathematics courses. Many other popular courses of study require advanced mathematics as well.

Two-year colleges often require all students to gain an understanding of intermediate algebra prior to graduation, regardless of their course of study. Many two-year colleges require all degree-seeking students to take mathematics placement exams prior to enrollment. High scorers may be exempt from taking certain mathematics courses, while low scorers may have to take remedial mathematics courses. Many of the most popular majors at two-year colleges--including Business, Nursing, and Computer Science--require more rigorous mathematics course work, such as statistics.

Four-year colleges and universities typically require more high school mathematics preparation for admission. Typical state four-year colleges and universities recommend, and in some cases, require, that all students take at least three, and sometimes four, years of mathematics in high school. Data collected by the College Board reveal that in 1997, 68 percent of incoming freshmen at four-year colleges and universities had taken four years of mathematics in high school. Furthermore, almost all of these students had taken algebra and geometry, and more than half had taken trigonometry. Most state colleges require students to take mathematics placement exams upon enrollment. Colleges look favorably on Advanced Placement courses and often place students who have taken them out of introductory mathematics courses. While graduation requirements differ depending on the students' major, many popular majors, such as Business and Psychology, require students to take several more rigorous courses in mathematics or science.

In the job market, workers who have strong mathematics and science backgrounds are more likely to be employed and generally earn more than workers with lower achievement, even if they have not gone on to college. A national survey found that by age 30, high school graduates who had not furthered their education but had scored in the top quartile on the mathematics portion of the Armed Services Vocational Aptitude Battery (ASVAB--administered to civilians for study purposes) earned, on average, 38 percent more per hour than high school graduates who had not gone to college and had scored in the bottom quartile of the mathematic portion of the ASVAB. Similarly, the unemployment rate among high school graduates who scored in the top quartile of the mathematics test was only 4.4 percent. The unemployment rate was 10.3 percent

among high school graduates who scored in the lowest quartile. Workers who scored in the top quartile of the science section of the ASVAB also earned more, on average, and were less likely to be unemployed.

Mathematics ability will be even more important for well-paying jobs in the future. Some major firms already require job applicants to pass standardized mathematics and reading tests. For example, Diamond-Star Motors, a joint venture of Chrysler and Mitsubishi, tests all applicants for production and maintenance positions on their ability to do high school level mathematics. Authors Richard Murnane and Frank Levy have identified a set of "New Basic Skills," in their book of the same name, that non-college-bound high school graduates should master in order to get well-paying jobs in the modern labor market. The "New Basic Skills" that workers will need in order to earn a good wage include the ability to use mathematics skills and concepts **at least** at the 9th grade level.

Shortages in workers skilled in mathematics and science could affect U.S. performance in global markets. According to a recent report, *America's New Deficit: The Shortage of Information Technology Workers,* from the Office of Technology Policy at the U.S. Department of Commerce, as computer and data processing become more important to the economy, more and more workers skilled in mathematics- and science-related disciplines will be needed to maintain the U.S.'s international competitiveness. The report cites a survey by the Information Technology Association of America indicating that 50 percent of company executives in information technology report a lack of skilled workers as "the most significant barrier" to their companies growth during the next year. However, the number of bachelor level computer science degrees awarded by U.S. colleges and universities declined more than 40 percent between 1986 and 1994, indicating that these problems are likely to persist.

Mathematics and Science in the Modern Job Market

Many jobs in today's labor market require a mathematics or science background. A number of these are among the fastest growing occupations nationally, and are not ones ordinarily thought of as "technical." Projections from the Bureau of Labor Statistics' (BLS) Occupational Outlook Handbook indicate that between 1994 to 2005, jobs requiring the most education and training will be the fastest growing and highest paying. BLS predicts that occupations requiring a bachelor's degree or higher will average 23 percent growth, almost double the 12 percent growth rate projected for occupations that require less education and training.

Many jobs that once required little background in mathematics now call for specific skills in algebra, geometry, measurement, probability, and statistics. According to an industry-wide standard, an entry level automobile worker needs to be able to apply formulas from algebra and physics to properly wire the electrical circuits of any car. The National Coalition for Advanced Manufacturing has defined 25 specific standards of mathematics and measurement among their national skill standards for what a good competent worker should know and be able to do.

Several of the fastest growing job areas will reflect growth in computer technology and health services--fields that can require substantial mathematics and science preparation. Generally speaking, fields requiring a strong science base also require substantial mathematics preparation, as most academic science programs build upon a strong background in mathematics. Below are some of the jobs which BLS indicates require a mathematics or science background; while many of these jobs require mathematics or science course work beyond the high school level, all require at least a high school level background. The occupations that BLS projects will be among the fastest growing during the period from 1994 to 2005 are noted with a star (*).

Computer Scientists (*)
Systems Analysts (*)
Occupational Therapy Assistants and Aides (*)
Chemical Engineers
Civil Engineers
Aerospace Engineers
Medical Assistants (*)
Dentists and Dental Hygienists
Surveyors
Surgical Technologists
Dieticians and Nutritionists
Optometrists
Physical Therapists (*)
Roofers
Tool and Die Makers
Photographers
Financial Managers
Budget Analysts

Middle School: Getting on the Road to Challenging Mathematics and Science Courses

Laying the Foundation

> "Mathematics is the language of science, and algebra is the minimum vocabulary that scientists of every discipline use to describe their work."
>
> -Dr. George Castro, Associate Dean of the College of Science at San Jose State University

Algebra is the "gateway" to rigorous mathematics courses. Rigorous mathematics courses build upon the skills and concepts that students learn in earlier mathematics courses. Traditionally, students cannot take a rigorous mathematics course in high school until they have successfully completed one or more prerequisite courses. Algebra I, or another course that covers basic algebraic concepts, is the prerequisite for more rigorous mathematics in high school.

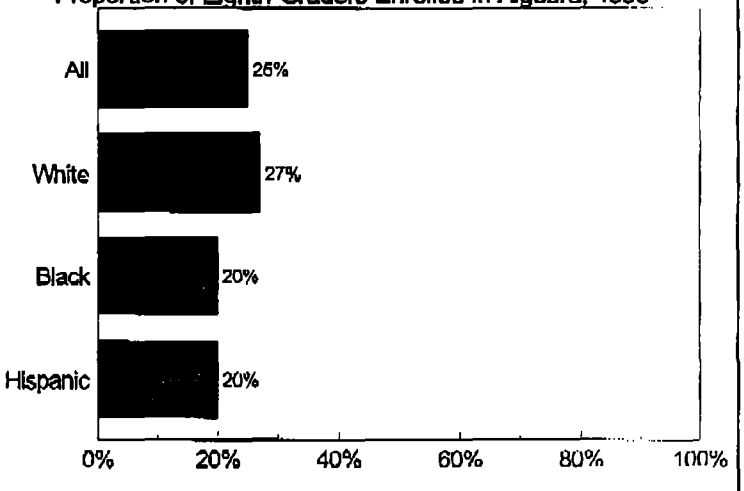
Students who plan to take advanced mathematics and science courses during high school and begin to study algebra during middle school are at a clear advantage. A rigorous sequence of mathematics spans several years. The traditional sequence of mathematics courses involves one year courses in algebra I, geometry, and algebra II, followed by a half-year course in trigonometry, a full- or half-year course in pre-calculus, and then calculus or an Advanced Placement course. Increasingly, schools are covering these rigorous content areas in courses that integrate algebra, geometry and other areas of mathematics such as statistics and probability, rather than teaching each separately. According to NELS, approximately 60 percent of the students who took calculus in high school had taken algebra in the 8th grade. The typical high school sequence of rigorous science courses (biology, chemistry, and physics) also necessitates an early background in algebra and geometry.

Students who do not take courses covering algebraic concepts early in their educational career risk closing the door on many important opportunities, including opportunities to take courses outside of mathematics and science. Some high schools require students to complete a specific package of courses, including mathematics and science, in order to graduate. By the junior and senior years, students who have not planned ahead have fewer options in choosing which courses they take. Students who do not complete prerequisite and required courses early enough not only risk being unable to take more rigorous courses in those disciplines later, but also may not have time in their schedules to take other courses that can help prepare them for college or a career, including foreign language, art, Advanced Placement, and "tech prep" courses.

Course-Taking Patterns in Middle School

Despite recent increases in the proportion of students taking algebra I in the 8th grade, in 1996, most students were not enrolled in this course. The proportion of 8th-graders taking the National Assessment of Educational Progress (NAEP) mathematics assessment who reported taking algebra has increased. In 1992, only 20 percent of students reported taking algebra. In 1996, the next year the NAEP mathematics assessment was administered, 25 percent reported taking algebra. This increase may be due to a number of factors, including the National Council of Teachers of Mathematics' (NCTM) call for including algebraic topics in the middle school curriculum.

Figure 4
Proportion of Eighth-Graders Enrolled in Algebra, 1996



Source: 1996 NAEP Mathematics Assessment background questionnaire

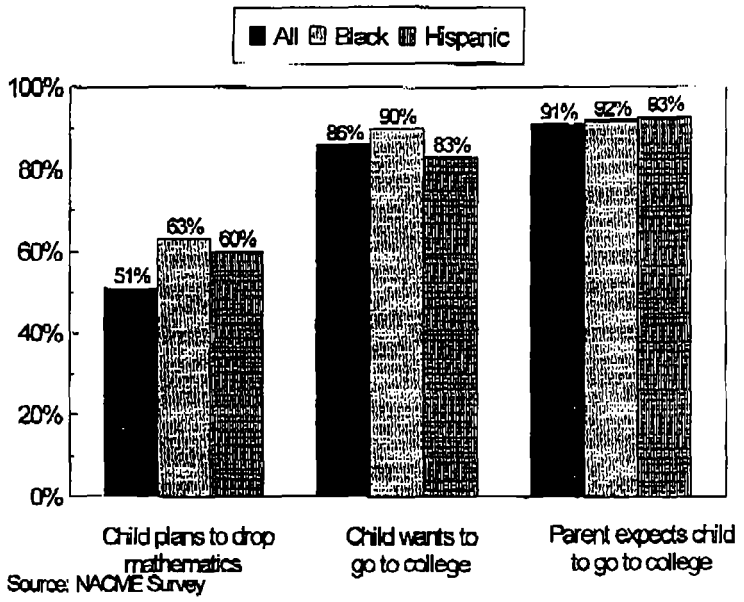
Minority and low-income students continue to be less likely to take challenging mathematics courses in middle school than other students. The 1996 NAEP data reveal that minority students are less likely to report being enrolled in algebra in the 8th-grade (Figure 4). The data also indicate that students from disadvantaged backgrounds are less likely to be enrolled in algebra during the 8th grade: While 29 percent of students who were not eligible for the national school lunch program reported being enrolled in algebra during the 8th grade, only 15 percent of students who were eligible for the national school lunch program were enrolled in algebra.

While the number of students taking algebra courses has increased, recent evidence suggests that the content of these courses has remained rigorous. Many states have recently increased mathematics requirements for high school graduation, often requiring that students take more years of mathematics than were required in the past, or mandating that students complete certain courses. A recent study supported by the National Science Foundation (NSF) examined the content of mathematics courses in schools in several of the states making the most substantial changes in mathematics requirements. The study focused on basic courses, such as algebra I, which had experienced large enrollment increases because of more stringent graduation requirements. Despite the larger numbers of students enrolling in the courses, the study found that the content of these courses was essentially unchanged, indicating that more students were, in fact, being exposed to rigorous mathematics.

Parent and Student Attitudes about Mathematics and Science

Large proportions of middle school students indicate that they do not plan to take mathematics and science courses beyond what their schools require. A nationally representative survey of public school students and parents conducted by Louis Harris Associates for the National Action Council for Minorities in Engineering (NACME), Inc. found that large proportions of students would like to **stop** taking mathematics and science courses as soon as they can. Fifty-one percent of the 5th through 11th grade students surveyed indicated that they would take mathematics classes only as long as required, while 47 percent reported they would study science only as long as it is required. Distressingly, young minority students--5th through 8th graders who will soon be facing major decisions about which courses to take--were more likely to indicate that they planned to drop mathematics and science as soon as they were able to (61 percent planned to drop mathematics, and 58 percent planned to drop science). Minority students of all ages were more likely than other students to say that they would like to stop taking mathematics and science as soon as they could (Figure 5).

Figure 5
Students Plan to Drop Mathematics, But Want to Go to College



However, the same students indicate that they would be interested in going to college, and taking college-level mathematics courses. Eighty-six percent of all students surveyed said that they would like to go to college. Although less than half of the 9th- to 11th-grade students said that they planned to take trigonometry or algebra II in high school, nearly two-thirds said that they were interested in taking Advanced Placement courses. These contrasts signal that many students do not understand the importance of, and requirements for, taking rigorous mathematics and science courses in high school, including the need to take algebra by the 8th grade. In fact, only 25 percent of minority and 42 percent of non-minority 5th- through 8th-grade students recognized that if they did not take algebra they would not be able to take other mathematics classes in the future.

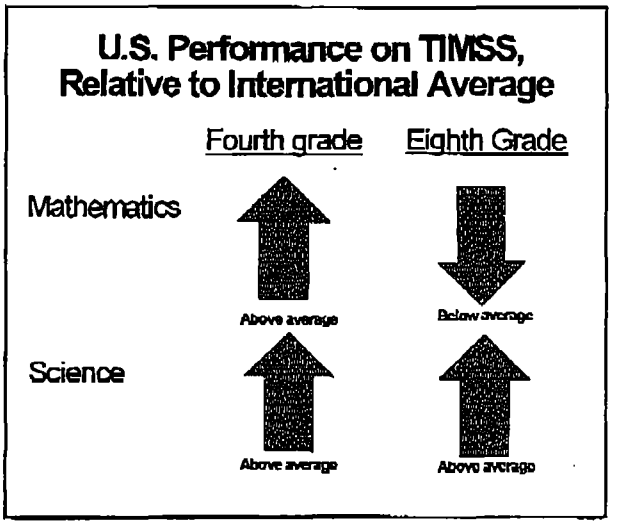
Parent and teacher involvement may make a large difference in students' decisions about mathematics and science. According to the NACME survey, ninety-four percent of students indicated that their parents' or guardians' advice was important to them in deciding what they

would study in school, and 88 percent indicated their teachers' advice was important. Ninety-one percent of parents want their children to continue their education beyond high school. However, when 9th- through eleventh-graders were asked who decided which mathematics classes they would take, 79 percent indicated that they had made the decision by themselves.

Analysis of the NELS data indicates that students with greater levels of parental involvement are more likely to take advanced mathematics courses. Analysis of the course-taking patterns of the NELS students who were in 8th-grade in 1988 reveals that regardless of whether the level of parent involvement was reported by the student, the parent, or the teacher, higher levels of parental involvement were consistently associated with higher likelihoods of taking rigorous mathematics courses. While only 8 percent of those students who said that they did not discuss programs at school with their parents took algebra I by the 8th grade, 17 percent of those who said that they discussed school programs three or more times during the previous semester took algebra I by the 8th grade. Students whose parents or teachers indicated greater levels of parental involvement were also more likely to take advanced courses. Thirty-seven percent of students whose parents said that they rarely talked to their child about high school plans took geometry by the 10th grade, while 48 percent of those students whose parents said they regularly spoke to the child about high school plans took geometry by the 10th grade. While 27 percent of students whose teachers said their parents were not involved took geometry by the 10th grade, a full 63 percent of the students whose teachers said that their parents were very involved took geometry by the 10th grade.

Mathematics in the U.S. Today

International Comparisons of Middle School Mathematics and Science Proficiency



Recent findings from the Third International Mathematics and Science Study (TIMSS), indicate that the mathematics curriculum from grades five through eight may be a weak link in the U. S. educational system. Newly available data from TIMSS (the most comprehensive international comparison of schools and students ever undertaken) reveal that U.S. 4th graders scored above the international average in both mathematics and science. Among 25 other participating nations, only Korea performed better than the U.S. in 4th grade science, and only 7 of the 25 other countries did better than the U.S. in 4th grade mathematics. These findings are in contrast to earlier findings from TIMSS that indicate that U.S. 8th graders perform slightly below the international average in mathematics, and only slightly above the international average in science. In fact, only one country--the U.S. in mathematics--falls from above the international average at 4th grade to below the international average at 8th grade.

The U.S. expects less of its middle school students compared to high performing nations. TIMSS data suggest that one reason U.S. students do less well at 8th grade is that the middle school mathematics curriculum in the U.S. is significantly less challenging than curricula in other countries. In Germany and Japan, virtually all students in grades 5 through 8 move beyond arithmetic to the foundations of algebra and geometry. By 8th grade, mathematics courses in virtually all other countries participating in TIMSS include significant algebra and geometry, while in the U.S., only students in college-preparatory classes receive significant exposure to algebra, and very few students study geometry. As a result, the content taught in U.S. 8th grade mathematics classrooms is usually at a 7th-grade level compared to the 40 other nations in the TIMSS study.

TIMSS also found that U.S. mathematics classes require students to engage in less high-level mathematical thought and solve fewer multi-step problems than classes in Germany and Japan. A U.S. mathematics teacher's typical goal is to teach students the mechanics of solving a problem versus understanding the concepts behind it, while a Japanese teacher's goal is to help them learn the basics as well as understand the relevant mathematical concepts. In a typical U.S. classroom, students follow the teacher as he or she leads them through solutions to mathematics

problems. In Japan, students are asked to solve problems, present them to the class, and describe how they approached the problem to increase their own understanding.

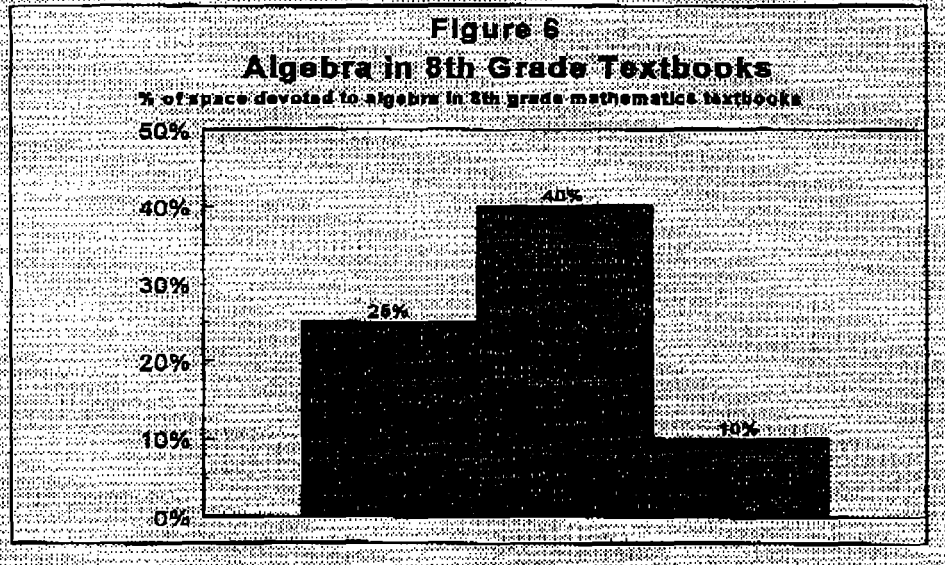
How Does Our Curriculum Compare Internationally?

The 8th grade mathematics curricula in both Germany and Japan are more advanced than in the United States. The TIMSS analysis of U.S. curricula examined both the content of textbooks and how it is implemented in classrooms.

- An analysis of curricula in the U.S. and other countries found that algebra and geometry occupy more space[1] in German and Japanese textbooks than they do in the textbooks used by a majority of U.S. 8th graders (Figure 6).

- Analyses of curriculum implementation make clear that in the middle school years, the U.S. still focuses on arithmetic. For example, 40 percent of U.S. 8th grade mathematics lessons included arithmetic topics, whereas only 13 percent of Germany's and none of Japan's lessons at the 8th grade level included these topics. The major focus of curriculum taught in these countries is on algebra and geometry.

Figure 6
Algebra in 8th Grade Textbooks



[1]Space is defined in terms of the percentage of a textbook or guidebook that is devoted to particular topics/blocks. Topics include such items as formulas, geometry, numbers, and estimation. Blocks are sub-units of topics that are parts of a textbook and which might include individual pedagogical suggestions, individual examples, individual testing, narrative blocks, graphic blocks, suggested activities, and mathematical problems.

Promising Practices

Across the country, there are many promising mathematics and science practices underway. Many of these are responsible for increases in the numbers of students taking rigorous courses in mathematics and science. Just as important, many students are finding that they do quite well in these more advanced courses. There is, of course, no one formula to success. Highlighted here are a number of places that demonstrate effective strategies.

Getting Set for Success. The Algebra Project, supported by the National Science Foundation (NSF) and directed by Robert Moses, addresses equity of opportunity by helping 6th, 7th, and 8th graders in inner city and rural areas understand challenging mathematics. Based on the conviction that all students can learn algebra given the proper context, the Algebra Project serves over 40,000 low-income and minority middle school students in 22 urban and rural sites in 13 states. Part of what makes the Algebra Project successful is that students study algebra as early as possible. This ensures their access to a college preparatory high school curriculum.

The project introduces rigorous mathematics concepts in 6th grade, creating a foundation to build upon throughout the middle school years. Using a variety of strategies, it has been successful in helping traditionally underserved students complete algebra I by the 8th or 9th grades, and either pre-calculus or calculus by the 12th grade. For example, one strategy is to place young college-age students in schools to provide extra assistance. In addition, the project provides after-school activities for students, and professional development for teachers. Teacher professional development highlights beliefs about the curriculum and how it should be taught.

The Algebra Project has produced positive effects in the Mississippi Delta and in Jackson, Mississippi. Additionally, an evaluation team of education experts from across the country found evidence of positive outcomes in teaching, student attitudes about and engagement in mathematical ideas, and community involvement.

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Taking the Right Courses. In 1990, the College Board launched EQUITY 2000 to increase minority enrollment in college preparatory mathematics courses. Originally piloted in six communities, EQUITY 2000 requires participating school districts to phase out lower-level mathematics in favor of all students taking college preparatory curriculum--beginning with algebra and geometry. EQUITY 2000 influences policies, curricula and student academic

development at all grade levels, but particularly grades six through nine. These are critical years for mathematics education. During this period, parents, students, and educators make key decisions about which courses students should take and how they should begin planning for education and careers after high school. Equity 2000 provides on-going professional development to help teachers work with mixed-ability classes. It also trains administrators and teachers to use student enrollment and achievement data to drive school-based decision-making, helps schools establish support services for students who need extra time and effort to learn challenging content, and encourages and supports parents to become advocates on behalf of their children.

Increased parental involvement is a priority in Equity 2000. It recognizes the important role that parents play in nurturing and reinforcing their children's desire to attend college. Equity 2000 has sponsored Saturday and summer academies on college campuses for entire families. It also sponsors Family Math nights in which parents and students learn mathematics concepts together.

Results at the six pilot sites indicate that:

- All sites dramatically increased the percentage of students enrolled in algebra I by the 9th grade, and in three pilot districts, all 9th graders enrolled in algebra I.

- The percentage of students passing algebra I did not decline significantly, and in some cases rose, as more students from the discontinued lower tracks began enrolling in algebra classes.

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Advanced Placement Participation and Scores on the Rise. The College Board's Advanced Placement (AP) Program was started nearly four decades ago to enable students to complete college-level studies while still in high school and to obtain college credit or placement. AP courses are widely recognized as setting the standard for high levels of academic achievement in high school. Today more than 500,000 students in about half of the nation's high schools take at least one AP course. Dramatically increased participation in AP courses in Texas and South Carolina illustrate the success of AP-based reform initiatives in two states.

Texas: The Advanced Placement Incentives program was developed in the Dallas, Texas area by O'Donnell Foundation in reaction to low rates of college attendance and poor college preparation. The Advanced Placement Incentives program reward results in AP courses in mathematics, science, English, and the arts by providing performance-based financial incentives to teachers, school and students. Teachers are given financial incentives as well as registration and fees for attending College Board AP teacher training during the summer, and to teach AP courses. Students who complete the Advanced Placement course may take the AP exam at half-cost (the total cost for an AP exam is about $73). Those who score a three or better (on a five point scale) are given financial incentive and reimbursed for the cost of the exam.

In five years of operation in nine Texas public schools, the O'Donnell foundation reports that:

- The year before the program began in nine typical public high schools, 48 students took AP exams in mathematics, science, and English, and received a three or better. In the fifth year of operation, 1,099 students took AP exams and 521 received a score of three or better.
- In nine high schools in the Dallas Independent School District, the eighth largest inner-city school district in the country, with 85 percent minority enrollment, growth in AP participation has been outstanding. Students took 312 AP in mathematics, science, and English in May 1995, the year before the program started in the Dallas schools. In May 1997, the second year of the Dallas program, this number has grown to 1,750. The number of students scoring three or higher during that time period grew from 139 to 559.

- The Dallas school program has experienced proportional growth among female and minority students. The year before the program started, 94 females took exams in mathematics, computer science, and the sciences. In the program's second year, 452 female students took these exams.

- Minority participation has also grown in Dallas, from 64 7 African-American and Hispanic students taking AP mathematics, science, and English exams the year before the program began, to 734 in the program's second year.

South Carolina: With former Governor Riley's school reform package of 1984, South Carolina became one of the first states to legislate funding and other actions to boost student participation in AP classes. The state appropriated funds to train AP teachers and to help pay for AP exams, as well as required that public colleges accept AP courses if the student scored 3 or higher on the exam. As a result, from 1984 to 1997 South Carolina experienced:

- An increase in the number of students taking AP exams from 2,799 to 9,748.
- An increase in the number of AP exams from 3,461 to 14,890, with the mean grade remaining stable at approximately 2.7 - 2.8.
- An increase in the number of AP science exams (Biology, Chemistry, Physics) from 27 to 2,414.

- An increase in the number of AP math exams (Calculus AB and BC) from 46 to 2,767.
- Ninety-three percent of all the public high schools in the state participating in AP (184 of 197 public high schools).
- AP participation rates above the national average.

AP Exams Taken
(Eleventh and Twelfth Graders)

	1984	1997	Percent increase
South Carolina	3,461	14,890	77 percent
National	223,888	843,399	73 percent

Sources: College Board. *Advanced Placement Program, National and South Carolina Summary Reports, 1984 - 1997.*

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Strengthening Curriculum and Instruction. Sponsored by the University of Pittsburgh's Learning Research and Development Center, the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project aims to raise low levels of student participation and performance in mathematics. QUASAR is an urban middle school demonstration project that fosters the development and implementation of improved mathematics instructional programs in economically disadvantaged communities. The program revolves around three key principles: (1) all students are able to learn a broad range of mathematical content; (2) all students can acquire a deeper and more meaningful understanding of mathematical ideas; and (3) all students can demonstrate proficiency in mathematical reasoning and complex problem solving.

In QUASAR schools, teams of mathematics teachers, school administrators and "resource partners"-- generally mathematics educators from local universities -- collaborate to develop, implement, and refine mathematics instruction. All project schools have eliminated most forms of academic tracking, replacing it with the development of deeper student understanding and

high-level thinking and reasoning for all students. While curricula, teaching strategies, and approaches to professional development vary, all QUASAR sites include extensive attention to professional development and teacher support. Additionally, the University of Pittsburgh's Learning Research and Development Center provides schools with ongoing support and updated information on their progress.

Data indicate that QUASAR schools build teachers' capacity to improve the quality of their mathematics instruction. Students increase their capacity to think, reason, solve complex problems, and communicate mathematically and they do so while continuing to learn basic skills. QUASAR school students, particularly those who are from minority groups and whose English proficiency is limited, have increased their understandings across a range of important mathematical ideas. Additionally, QUASAR students in grade 8 performed as well as other students on basic and traditional items of the 1992 NAEP Mathematics Assessment. They performed better than their peers on less traditional middle school mathematics content.

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Raising the Standard. The New York Regents Exam has spurred thousands more high school students to take and pass college-preparatory mathematics courses. In 1993 then New York Chancellor Ramon Cortines required all students to take tougher Regents-level mathematics and science courses traditionally reserved for college-bound students. Beginning in 1995, the state required that all students take Regents-level classes. The number of Hispanic and black students who passed the science portion of the Regents Exam more than doubled over the previous year. The state is now requiring all students take and pass Regents Exams. In addition, Commissioner of Education Richard Mills recently called for an increase in the rigor of the state's requirements for graduation from high school, including adding another year of both mathematics and science to the current two years required in each.

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Living Up to Potential. Twenty school districts from Chicago's North Shore joined forces in 1995 to provide their students with a world class education in mathematics and science. Calling themselves the First in the World Consortium, their first challenge was to determine what a "world class" education looked like. They then measured their current performance against that benchmark and developed an improvement strategy.

The Consortium's directed its efforts toward three objectives: (1) benchmarking performance against international standards in mathematics and science, using the Third International Mathematics and Science Study as a guide; (2) creating a forum to clarify world-class education standards for business leaders, policy makers, educators, and community members; and (3) establishing a network of learning communities for educators, parents, and community leaders within the Consortium school districts and beyond.

Students in grades 4, 8, and 12 in First in the World Consortium districts took the TIMSS assessment in Spring 1996. Fourth and eighth graders' results placed them among the top performers in the world, well exceeding U.S. performance generally.

The Consortium attributes its success to the fact that:

- Fifty percent of its 8th grade students took algebra or geometry compared to 25 percent of students nationally who take algebra;
- it had high expectations for students and teachers; and
- it had gained broad-based community support for improved student performance.

The First in the World Consortium is not resting on its success. Its "community of learners" approach continues to promote teacher participation and provide a context for long-term commitment to the consortium's goals and to growth in student learning. To this end, it has created teacher learning networks to strengthen curriculum standards, models of instruction, assessment, and use of technology.

The resources of the First in the World Consortium place it at an advantage. Yet, what truly distinguishes it is its willingness to identify its weaknesses and address them. The consortium credits both state and federal support for helping it focus on its goals. Its experiences demonstrate that, when given the opportunity, U.S. students can perform as well as, or better than, students anywhere.

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Next Steps

Six things educators, policymakers and community members can do:

1. Provide all students the opportunity to take algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in all four years of high school.

2. Build the groundwork for success in algebra by providing a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares students for the transition to algebra.

3. Ensure that all students, parents, teachers, and counselors understand the importance of students' early study of algebra as well as continued study of rigorous mathematics and science in high school.

4. Provide teacher preparation and professional development to teachers of mathematics to increase their knowledge and skills in mathematics and the teaching of mathematics.

5. Support mathematics achievement outside the classroom through math clubs, tutoring, and job shadowing for students who may need extra help.

6. Support parent involvement in their children's mathematics education.

Six things parents can do:

1. Discuss your children's mathematics homework with them.

2. Visit your children's mathematics teacher to find out what your children are learning and how you can help.

3. Insist that your children enroll in algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in high school so they can keep all of their future options open.

4. Ensure that your children are gaining the groundwork for success in algebra through a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares them for the transition to algebra.

5. Help your children understand the importance of taking challenging mathematics and science courses to their future by visiting colleges, familiarizing them with college requirements, and exploring financial aid options available to students.

6. Show the importance of mathematics for career choices by talking with your children about the use of mathematics in your work or the work of adults they know.

Resources

Everson, Howard T. and Marlene Dunham. *"Signs of Success—EQUITY 2000, Preliminary Evidence of Effectiveness."* New York, NY: The College Board, 1996.

Hawes, Mark, Kimmelman, Paul, and Kroeze, David. "Becoming 'First in the World' in Math and Science: Moving High Expectations and Promising Practices to Scale." *Phi Delta Kappan*, Volume 79, Number 1, September 1997.

Jones, Vinetta C. "What A Difference A Standard Makes." In D. Bartels & J. Opert Sandler (Eds.), *This Year in Science: Implementing Science Education Reform."* Washington, DC: American Association for the Advancement of Science, in press.

Levy, Frank and Richard Murnane. *Teaching the New Basic Skills: Principles for Educating Children to Thrive in a Changing Economy*, New York: The Free Press, 1996.

National Action Council for Minorities in Engineering. *Uninformed Decisions: A Survey of Children and Parents about Math and Science,* Conducted for National Action Council for Minorities in Engineering, By Louis Harris and Associates, 1995.

The National Commission on Teaching and America's Future. *What Matters Most: Teaching for America's Future*, September, 1996. http://www.tc.columbia.edu/~teachcomm/index2.htm

Porter, Andrew. "The Effects of Upgrading Policies on High School Mathematics and Science." Consortium for Policy Research in Education, 1997, and in Brookings Papers on Education Policy, 1997.

Schmidt, William H., McNight, Curtis C., and Raizen, Senta A. *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, East Lansing, MI: U.S. National Center for the Third International Mathematics and Science Study, Michigan State University, 1996. http://kapis.www.wkap.nl/kapis/CIG-BIN/WORLD/book.htm?0-7923-4441-3

U.S. Department of Education. National Center for Education Statistics. *Education and the Economy: An Indicators Report*, Washington, D.C.: U.S. Government Printing Office, 1997. http://nces.ed.gov/pubsearch/infopage.idc?cid=97269XXXXX

U.S. Department of Education. National Center for Education Statistics. *NAEP Facts: Eighth-Grade Algebra Course-Taking and Mathematics Proficiency*, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/pubs/96815.html

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and*

Achievement in International Context, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/timss/

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, Washington, D.C.: U.S. Government Printing Office, 1997. http://nces.ed.gov/timss/

U.S. Department of Education. National Center for Education Statistics. *Statistics in Brief: Changes in Math Proficiency Between 8th and 10th Grades*, Washington, D.C.: U.S. Government Printing Office, 1996. http://nces.ed.gov/pubsearch/infopage.idc?cid=93455XXXXX

U.S. Department of Education. Planning and Evaluation Service. *Analysis of NELS:88 Follow-Up Data: Factors That Affect College Enrollment*, Forthcoming.

U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook*, Washington, D.C.: U.S. Government Printing Office, 1997. http://stats.bls.gov:80/ocohome.htm

Appendix

The NELS:88 data. The National Education Longitudinal Study of 1988 (NELS:88) initially surveyed a nationally representative sample of 26,000 public and private school 8th grade students in 1988. The data collected include responses to student questionnaires, scores on standardized achievement tests, high school transcripts, and interviews with parents and teachers. Since the initial survey in 1988, the students have been resurveyed every two years, with the most recent data available gathered two years after their scheduled high school graduation in 1994. The analyses in this report are based on a sub-sample of over 13,000 individuals from whom data were collected in all three follow-up surveys. Analysis of course-taking patterns is based on student reports of 8th-grade course-taking and high school transcript data. The actual titles of mathematics courses as they appear on the transcripts may vary, despite covering similar content (for example, geometric concepts); accordingly, we have attempted to include all courses under the traditional course names (i.e. "geometry," "algebra II") reflective of their content.

A Letter from the Secretary of Education

Many parents, students, and educators do not realize that within the United States today, mastering mathematics has become a gateway to the road to college--and taking algebra or courses covering algebraic concepts by the end of the 8th grade is a key to the "gate." Although almost all parents want their children to go on to college or some advanced training, many 8th and 9th graders may be behind in their course taking to get on the road to college, and not realize it.

Recent analyses conducted by the U.S. Department of Education indicate that students with strong mathematics backgrounds--those who take algebra and geometry and more rigorous mathematics courses during high school--are more likely to go on to college. This is true regardless of their family's level of income. In fact, the positive impact of taking rigorous courses is most dramatic for students from low-income families. In addition, students who took chemistry, a subject which requires a strong background in mathematics, were also more likely to go to college. Other research tells us that the benefits of a strong background in mathematics are not limited to college-going, and workers with high levels of mathematics achievement earn more and are less likely to be unemployed than workers who are less proficient in mathematics.

However, not all students have access to rigorous mathematics courses--either because their school may not offer a full selection of challenging courses to all students, or because students are not prepared for and encouraged to take them. The results of the recently completed Third International Mathematics and Science Study (TIMSS) confirm that many students enter high school without a solid grounding in mathematics, closing doors very early to opportunities for further education and better career opportunities.

The implications are clear: The 8th grade is a critical point in mathematics education. Achievement at that stage opens opportunities for students to take rigorous high school mathematics and science courses important for later success. As a nation, we must ensure that all our students develop the necessary mathematics background by the end of the 8th grade--and build on that foundation throughout high school. We challenge parents, schools, community groups, colleges, universities, and employers to ensure that all children have access to rigorous mathematics courses and encourage them to go to college. To assist in that effort, the U.S. Department of Education stands ready to assist states, local communities, and individual students by providing federal student financial aid for college, by supplementing Advanced Placement Exam fees for students' who demonstrate need by providing funding through Title I of the Elementary and Secondary Education Act (ESEA) and other programs to assist schools in upgrading mathematics teaching and learning, and by providing a voluntary national test in 8th grade in mathematics to help ensure that all students are given the opportunity to excel.

Sincerely,

Richard Riley

Executive Summary

Within the United States today, mastering mathematics has become more important than ever. Students with strong mathematics backgrounds have advantages in academics and in the job market. The 8th grade is a critical point in mathematics education, and achievement at that stage opens opportunities for students to take rigorous high school mathematics and science courses that are keys to college entrance and success in the labor force. However, although most parents want their children to go on to college or some advanced training, most 8th and 9th graders are behind in their course taking to get on the road to college. Findings highlighted in this report include:

- **Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not.** Data from the National Educational Longitudinal Study (NELS) reveal that 83 percent of students who took algebra I and geometry went on to attend a two or four year college within two years of their scheduled high school graduation, compared to a college attendance rate of only 36 percent among students not taking algebra I and geometry; while nearly 89 percent of students who took chemistry went to college, only 43 percent of students who did not take chemistry in high school went to college.

- **Algebra is the "gateway" to advanced mathematics and science in high school--yet most students currently do not take algebra during middle school.** Students who plan to take advanced mathematics and science courses during high school and study algebra during middle school are at an advantage: Forty-six percent of students who took algebra I in the 8th grade took calculus in high school, compared to only eight percent of students who took algebra I in the 9th grade. However, 1996 NAEP data reveal that only 25 percent of 8th graders in the U.S. were enrolled in algebra, and that low-income and minority students are even less likely to be enrolled in algebra during the 8th grade.

- **Taking rigorous mathematics and science courses in high schools appears to be especially important for low-income students.** Low-income students who took algebra I and geometry were almost three times as likely to attend college as those who did not: While 71 percent of those who took algebra I and geometry went to college, only 27 percent who did not went on to college. By way of comparison, 94 percent of students from high income families, and 84 percent of students from middle income families who took algebra I and geometry in high school went on to college, while 60 percent of students from high income families and 44 percent of students from middle income families who did not take algebra I and geometry still did go on to college.

- **Despite the importance of taking rigorous mathematics and science courses for low-income students, they are less likely to take these courses.** Students from higher income families are almost twice as likely to take algebra in middle school and geometry in high school and more than twice as likely to take chemistry than lower income students.

Other important findings include:

- **Mathematics achievement depends on course-taking, not the type of school a student attends.** Students at public and private school who had taken the same rigorous mathematics courses were equally likely to score at the highest level on the NELS 12th grade mathematics achievement test.

- **Students who have parents who are involved in their school work are more likely to take challenging mathematics courses early.** Students whose parents were involved in their educations were more likely to take courses like algebra and geometry in the 8th and 9th grade, than students' whose parents were not involved.

- **The results of the Third International Mathematics and Science Study (TIMSS) reveal that the U.S. middle school mathematics curriculum may be a weak link in the U.S. educational system.** While U.S. 4th graders score above the international average in mathematics and science, U.S. 8th graders score below average in 8th grade mathematics, and only slightly above the international average in science. Initial analysis of the TIMSS data also shows that the U.S. middle school mathematics curriculum is not as challenging as that of other countries. The curriculum of average 8th-grade mathematics classrooms in the U.S. resembles 7th grade mathematics elsewhere. Although algebra and geometry are important elements in the middle school curriculum taught in other countries, only a small fraction of U.S. middle school students are exposed to these topics.

Algebra in the Curriculum

Making a successful transition from arithmetic to more advanced topics, including algebra and geometry, has often been difficult for students. As a result, many mathematics programs in the U.S. are now systematically incorporating some of the fundamental ideas from algebra and geometry into the upper elementary grades. In these programs, 5th, 6th and 7th grade students are learning about representing and solving equations, characterizing patterns and rates of change among variables, and other fundamental algebraic concepts.

In addition, the approach middle and high schools take to presenting advanced topics differs. Many schools offer the traditional model of pre-Algebra, Algebra I, Geometry, Algebra II, Trigonometry, pre-Calculus and Calculus. However, an increasing number of schools offer courses in which algebra, geometry and other advanced topics are more integrated. This approach is consistent with the practice in other industrialized nations which integrate algebra, geometry and other topics throughout the elementary, middle and high school years and offer a significant component of algebra in the 8th grade. Building a firm foundation in algebra in the elementary and middle school years makes the shift from arithmetic to advanced topics more successful, regardless of the format of the middle and high school curriculum. NELS and NAEP, the two sources of national course-taking data which are analyzed in this brief, employ traditional courses titles, such as "algebra I" and "geometry" for mathematics courses. Thus, these traditional titles are used throughout the brief.

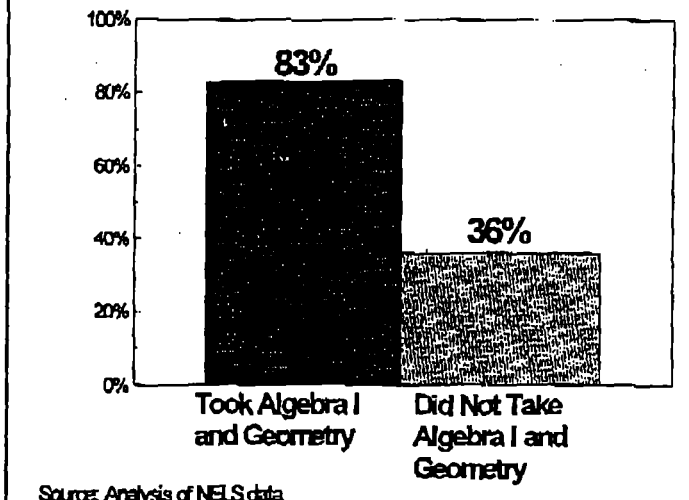
Table of Contents

Mathematics and Future Opportunities

The Importance of Mathematics for College Entrance

Students who take rigorous mathematics and science courses are much more likely to go to college than those who do not. Data from a longitudinal survey of students who were in the 8th grade in 1988 (National Educational Longitudinal Study or NELS) reveal that 83 percent of students who took algebra I and geometry went on to attend college[1] within two years of their scheduled high school graduation. By way of comparison, only 36 percent of students not taking algebra I and geometry went to college (Figure 1). Similarly, students who take rigorous science courses in high school are also much more likely to go to college: While nearly 89 percent of students who took chemistry went to college, only 43 percent of students who did not take chemistry in high school went to college. Students who take more rigorous mathematics courses also have higher gains in mathematics achievement (measured by the mathematics achievement test given as part of NELS) than students who take less challenging courses, even when controlling for achievement. For example, among students who initially began at the same level of mathematics proficiency in the 8th grade, those students who had taken algebra II or geometry by the 10th grade experienced greater gains, on average, than those students who had taken no algebra or only algebra I during the same period.

Figure 1
College Attendance by Course-Taking



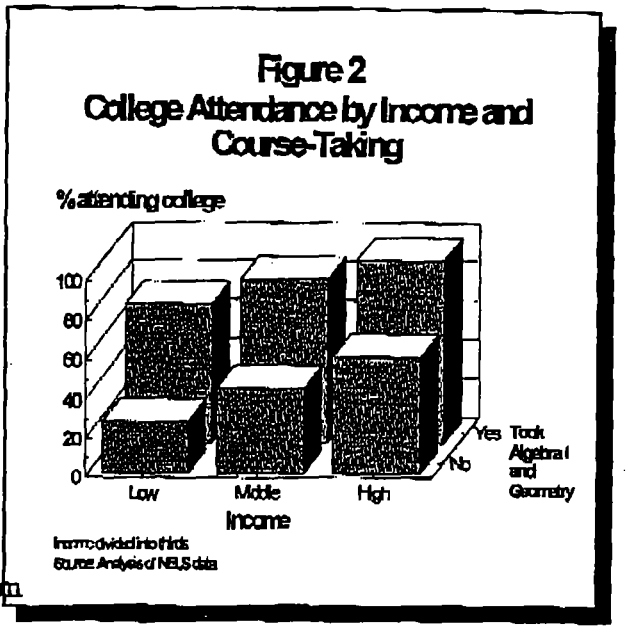
Source: Analysis of NELS data

Students of all income levels who take rigorous mathematics and science courses in high school are more likely to go to college, and among low-income students (students in the bottom third of the income distribution)[2], the difference is particularly dramatic. Students

[1]Throughout this report, the term "college" is used to refer to any postsecondary education taken at a public, private not-for-profit, or private for-profit institution.

[2]Income data are based on total family income reported by parents. Low, middle, and high income groups each contain approximately one-third of the sample. The "all" category includes additional observations with

from low-income families who took algebra I and geometry were almost three times as likely to attend college as those who did not: While 71 percent of low-income students who took algebra I and geometry went to college, only 27 percent of low-income students who did not take algebra I and geometry went on to college. The differences are also dramatic among students from middle- and high-income families: 94 percent of students from high-income families, and 84 percent of students from middle-income families who took algebra I and geometry went on to college, while 60 percent of students from high-income families and 44 percent of students from middle-income families who did not take geometry still did go on to college (Figure 2).



Unfortunately, many students, in particular low-income students, do not take these rigorous mathematics and science courses. According to NELS, 63 percent of all students took algebra 1 and geometry and 50 percent took chemistry. Students from low-income families, however, were far less likely than their peers to take these rigorous courses. Among students in the bottom third of the income distribution, 46 percent took algebra I and geometry and only 33 percent took chemistry. By way of comparison, fully 81 percent of students in the top third of the income distribution took algebra 1 and geometry, and 72 percent took chemistry. The differences are similar for other rigorous mathematics courses (Table 1).

missing income data.

Table 1: Course-Taking Patterns of NELS Students

	Percent of Students Taking Course			
	All	Bottom Income	Middle Income	Top Income
Algebra I and Geometry	63	46	68	81
Trigonometry	18	10	19	30
Chemistry	50	33	52	72

When course-taking patterns are accounted for, the difference in the rate of college-going between low and high income students is dramatically reduced. When course taking patterns are not accounted for, students from high-income families are almost twice as likely to attend college as students from low-income families (86 percent compared to 44 percent). However, when only students who have taken rigorous courses are compared to one another, students from low-income families go to college at rates much more similar to students from middle- and high-income families (Table 2). For example, among students who took chemistry in high school, 95 percent of high-income students; 89 percent of middle-income students; and 79 percent of low-income students went on to college. When low-income students take rigorous courses, income effects on college-going rates diminish greatly, although they do not disappear.

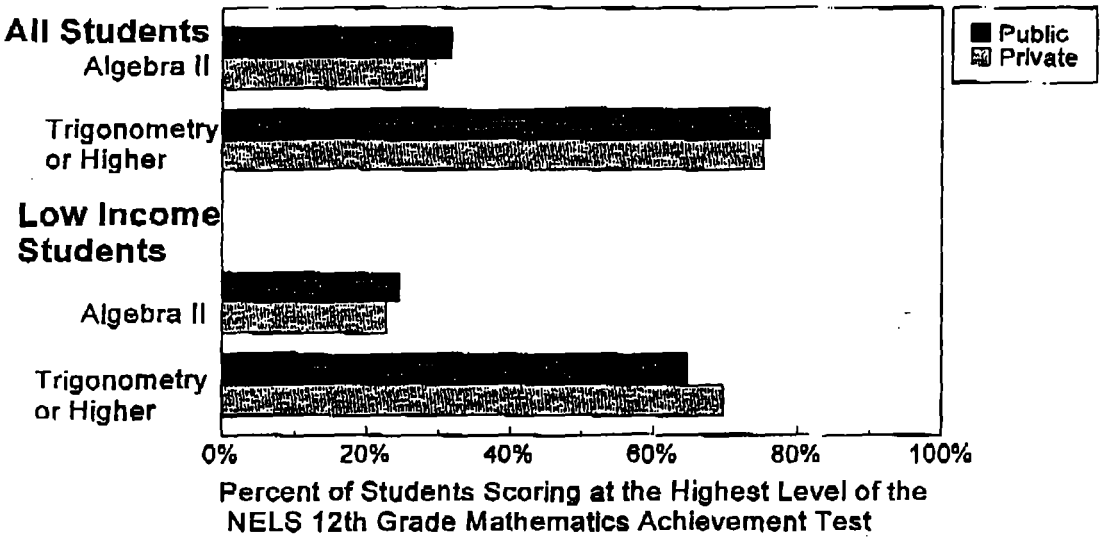
Table 2: College Attendance by High School Course-Taking Patterns of NELS Students

	Percent of Students Attending Postsecondary Education				
		All	Bottom Income	Middle Income	Top Income
	All	63	44	69	86
Algebra I and Geometry	Yes	83	71	84	94
	No	36	27	44	60
Trigonometry	Yes	94	90	92	98
	No	59	42	66	85
Chemistry	Yes	89	79	89	95
	No	43	31	50	68

Public Versus Private
Achievement Depends on Course-Taking, Not the Type of School

In general, the mathematics courses students take in high school are more important for achievement than the type of school attended. While recognizing that a great deal of diversity exists among public and private schools, it is useful to note that when course-taking patterns are accounted for, the mathematics achievement of students in both categories of school is very similar. Public and private school students who had taken the same mathematics courses were almost equally likely to score at the highest achievement level on the NELS 12th grade mathematics achievement test. This was also true for low-income public and private school students. Additionally, among both public and private school students of all incomes, students who had taken more rigorous mathematics courses were much more likely to score at the highest achievement level (Figure 3).

Figure 3
Mathematics Achievement by Highest Mathematics Course Taken



Achievement divided into thirds; Students in highest level scored in the top third
Source: Analysis of NELS data

1 Private schools include non-religious, Catholic, and other private schools.

1

Mathematics in College, the Workplace, and the 21st Century

The benefits of taking rigorous mathematics and science courses extend to both two- and four-year colleges, and to the job market. As the prevalence of technology in the workplace steadily increases, workers in more and more jobs will be required to have strong backgrounds in mathematics and science--backgrounds which begin to be formed during high school. Rigorous mathematics and science preparation is also important to students intending to go to a two or four year college or university. The level and number of mathematics courses that a student needs to take before and during college depend on the type of college and the major that the student wants to pursue, and while students who plan to major in mathematics- and science-related disciplines typically need to take a more rigorous mathematics program, many other popular courses of study also require strong mathematics backgrounds.

Two-year colleges often require all students to gain an understanding of intermediate algebra prior to graduation, regardless of their course of study. In many two-year colleges, all entering degree-seeking students are required to take mathematics placement exams prior to enrollment. Students who score high enough may be exempted from taking certain mathematics courses, while students with low scores may be required to enroll in remedial mathematics courses. Many of the most popular majors at typical two-year colleges--including Business, Nursing, and Computer Science--require more rigorous mathematics course work, such as statistics.

Four-year colleges and universities typically require more high school mathematics preparation for admission. Typical state four-year colleges and universities recommend, and in some cases, require, that all students take at least three, and sometimes four, years of mathematics in high school. Data collected by the College Board reveal that in 1997, 68 percent of incoming freshmen at four-year colleges and universities had taken four years of mathematics in high school. Furthermore, almost all of these students had taken algebra and geometry, and more than half had taken trigonometry. Upon enrollment, most state colleges require students to take mathematics placement exams. Advanced Placement courses are looked at favorably by colleges and can result in placement out of introductory mathematics courses. While graduation requirements differ depending on the student's major, many popular majors, such as Business and Psychology, require students to take several more rigorous courses in mathematics or science.

In the job market, workers who have a strong background in mathematics and science are more likely to be employed and generally earn more than workers with lower achievement, even if they have not gone on to college. A national survey found that by age 30, high school graduates who had not gone on to further education and had previously scored in the top quartile on the mathematics portion of the Armed Services Vocational Aptitude Battery (ASVAB--administered to civilians for study purposes) earned, on average, 38 percent more per hour than high school graduates who had not gone to college and had scored in the bottom quartile of the mathematic portion of the ASVAB. Similarly, the unemployment rate among high school graduates who scored in the top quartile of the mathematics test was only 4.4 percent, compared to an unemployment rate of 10.3 percent among high school graduates who scored in

the lowest quartile. Workers who scored in the top quartile of the science section of the ASVAB also earned more, on average, and were less likely to be unemployed.

In the future, ability in mathematics will be even more important for good-paying jobs. Today, some major firms now require that all job applicants pass standardized mathematics and reading tests, so that they may hire only individuals with solid backgrounds in these areas. For example, at Diamond-Star Motors, a joint venture of Chrysler and Mitsubishi, all applicants for production and maintenance positions must pass a standardized test that assesses their ability to do mathematics at a high school level. Authors Richard Murnane and Frank Levy have identified a set of "New Basic Skills," in their book of the same name, that, though fundamental for good-paying jobs in the modern labor market, are often not mastered by non-college-bound high school graduates. The "New Basic Skills" that workers will need to earn a good wage include the ability to use mathematics skills and concepts **at least** at the 9th grade level, yet currently many non-college bound students looking for work do not possess a sufficient mathematics background to do so.

Mathematics and Science in the Modern Job Market

Many jobs in today's labor market require a mathematics or science background. A number of these are among the fastest growing occupations nationally, and are not ones ordinarily thought of as "technical." Projections from the Bureau of Labor Statistics' (BLS) Occupational Outlook Handbook indicate that during the 1994 to 2005 period, jobs requiring the most education and training will be the fastest growing and highest paying. BLS predicts that occupations requiring a bachelor's degree or higher will average 23 percent growth, almost double the 12 percent growth rate projected for occupations that require less education and training.

Many jobs that once required little background in mathematics now call for specific skills in algebra, geometry, measurement, probability, and statistics. According to an industry-wide standard, an entry level automobile worker needs to be able to apply formulas from algebra and physics to properly wire the electrical circuits of any car. The National Coalition for Advanced Manufacturing has defined 25 specific standards of mathematics and measurement among their national skill standards for what a good competent worker should know and be able to do.

Several of the fastest growing job areas will reflect growth in computer technology and health services -fields that can require substantial mathematics and science preparation. Generally speaking, fields requiring a strong science base also require substantial mathematics preparation, as most academic science programs build upon a strong background in mathematics. Below are some of the jobs which BLS indicates require a mathematics or science background; while many of these jobs require mathematics or science course work beyond the high school level, all require at least a high school level background. The occupations that BLS projects will be among the fastest growing during the period from 1994 to 2005 are noted with a star (*).

Computer Scientists (*)
Systems Analysts (*)
Occupational Therapy Assistants and Aides (*)
Chemical Engineers
Civil Engineers
Aerospace Engineers
Medical Assistants (*)
Dentists and Dental Hygienists
Surveyors
Surgical Technologists
Dieticians and Nutritionists
Optometrists
Physical Therapists (*)
Roofers
Tool and Die Makers
Photographers
Financial Managers
Budget Analysts

Middle School: Getting on the Road to Challenging Mathematics and Science Courses

Laying the Foundation

> "Mathematics is the language of science, and algebra is the minimum vocabulary that scientists of every discipline use to describe their work."
>
> —Dr. George Castro, Associate Dean of the College of Science at San Jose State University

Algebra is the "gateway" to rigorous mathematics courses. Rigorous mathematics courses build upon the skills and concepts that students learn in earlier mathematics courses. Traditionally, students cannot take a rigorous mathematics course in high school until they have successfully completed one or more prerequisite courses that provide the foundation for the next course. Algebra I, or another course that covers basic algebraic concepts, is the prerequisite for more rigorous mathematics classes in high school.

Students who plan to take advanced mathematics and science courses during high school and begin to study algebra during middle school are at a clear advantage. A rigorous sequence of mathematics courses spans several years. The traditional sequence of recommended mathematics courses involves one year courses in algebra I, geometry, and algebra II, followed by a half-year course in trigonometry, a full- or half-year course in pre-calculus then calculus, or an Advanced Placement course. In addition, an increasing number of schools use curricula that cover these rigorous content areas, but integrate algebra, geometry and other areas of mathematics such as statistics and probability, rather than teaching each in a separate course. According to NELS, forty-six percent of students who took algebra I in the 8th grade took calculus in high school, compared to only eight percent of students who took algebra I in the 9th grade. The typical high school sequence of rigorous science courses (biology, chemistry, and physics) also necessitates an early background in algebra and geometry. Although not all students need to take all of the most rigorous mathematics or science courses that their school offers, most colleges encourage students to take four years of challenging mathematics and science courses during high school.

Students who do not take courses covering algebraic concepts early in their educational career risk closing the door on many important opportunities, including opportunities to take courses outside of mathematics and science. Some high schools require students to complete a specific package of courses, including mathematics and science, in order to graduate. By the junior and senior year, students who have not planned ahead to complete the courses that their school requires have fewer options in choosing which courses they take. Students who do not complete prerequisite and required courses early enough not only risk being unable to take more rigorous courses in those disciplines later, but also may not have time in their schedules to take other courses that can help prepare them for college or a career, including foreign language, art,

Advanced Placement, and "tech prep" courses.

Course-Taking Patterns in Middle School

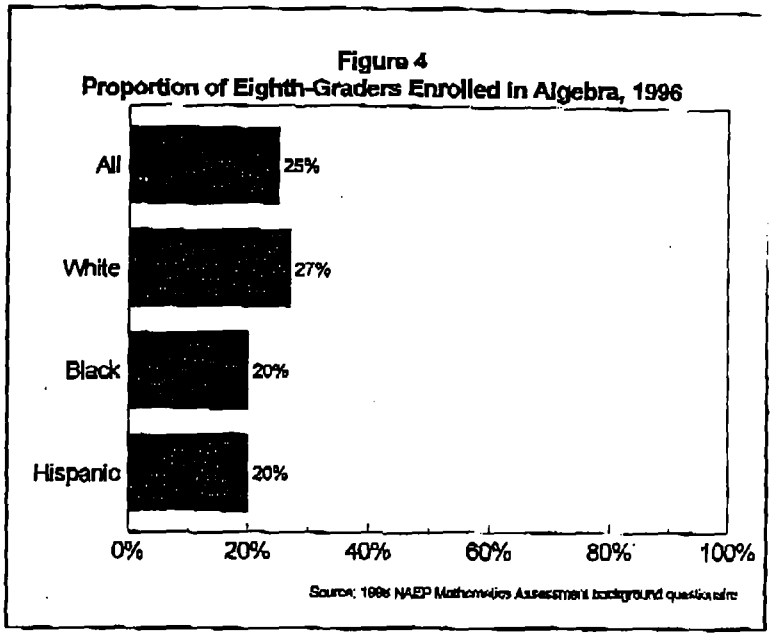


Figure 4
Proportion of Eighth-Graders Enrolled in Algebra, 1996

Despite recent increases in the proportion of students taking algebra I in the 8th grade, in 1996, most students were not enrolled in this course. The proportion of 8th-graders taking the National Assessment of Educational Progress (NAEP) mathematics assessment who reported taking algebra has increased in recent years. In 1992, only 20 percent of students reported taking algebra. In 1996, the next year the NAEP mathematics assessment was administered, 25 percent reported taking algebra. This increase may be due to a number of factors, including the National Council of Teachers of Mathematics' (NCTM) call for the inclusion of algebraic topics in the middle school curriculum. However, most students still were not enrolled in courses that include significant amounts of algebra in the 8th grade.

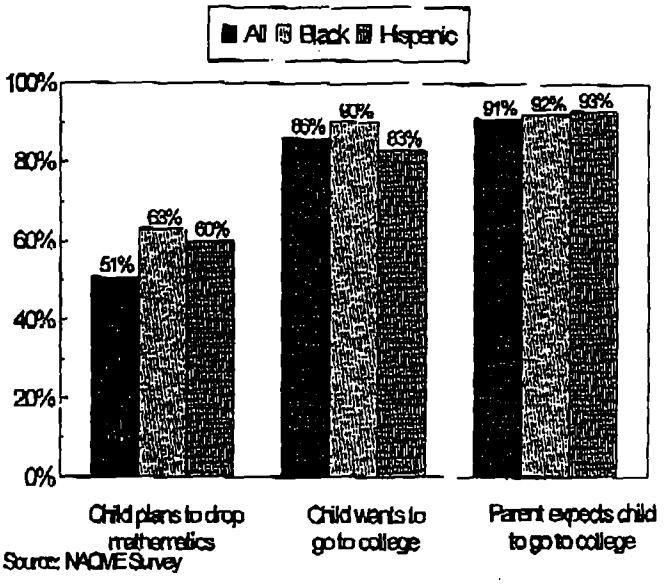
Minority and low-income students continue to be less likely to take challenging mathematics courses in middle school than other students. The 1996 NAEP data reveal that minority students are less likely to report being enrolled in algebra in the 8th-grade (Figure 4). The data also provide some indication that students from disadvantaged backgrounds are less likely to be enrolled in algebra during the 8th grade: While 29 percent of students who were not eligible for the national school lunch program reported being enrolled in algebra during the 8th grade, only 15 percent of students who were eligible for the national school lunch program were enrolled in algebra.

While the number of students taking algebra courses has increased, recent evidence suggests that the content of these courses has remained rigorous. Many states have recently increased mathematics requirements for high school graduation, often requiring that students take more years of mathematics than were required in the past, or mandating that students complete certain courses. A recent study supported by the National Science Foundation (NSF) examined the content of mathematics courses in schools in several of the states making the most substantial changes in mathematics requirements. The study focused on basic courses, such as algebra I, which had experienced large enrollment increases because of the more stringent graduation requirements. Despite the larger numbers of students enrolling in the courses, the study found that the content of these courses was essentially unchanged, indicating that more students were in fact being exposed to rigorous mathematics.

Parent and Student Attitudes about Mathematics and Science

Large proportions of middle school students indicate that they do not plan to take mathematics and science courses beyond what their schools require. A nationally representative survey of public school students and parents conducted by Louis Harris Associates for the National Action Council for Minorities in Engineering (NACME), Inc. found that large proportions of students would like to stop taking mathematics and science courses as soon as they are able to: 51 percent of the 5th through 11th grade students surveyed indicated that they would take mathematics classes only as long as required, while 47 percent reported they would study science only as long as it is required. Distressingly, young minority students--5th through 8th grade students who will soon be facing major decisions about which courses to take--were more likely to indicate that they planned to drop mathematics and science as soon as they were able to (61 percent planned to drop mathematics, and 58 percent planned to drop science). Minority students of all ages were more likely than other students to indicate that they would like to stop taking mathematics and science as soon as they were able to (Figure 5).

Figure 5
Students Plan to Drop Mathematics, But Want to Go to College



However, the same group of students indicate that they would be interested in going to college, and taking college-level mathematics courses. Eighty-six percent of all students surveyed said that they would like to go to college. Although less than half of the 9th- to 11th-grade students said that they planned to take trigonometry or algebra II in high school, nearly two-thirds said that they were interested in taking Advanced Placement courses. These contrasts signal that many students do not understand the importance of, and requirements for, taking rigorous mathematics and science courses in high school, including the need to take algebra by the 8th grade. In fact, only 25 percent of minority and 42 percent of non-minority 5th- through 8th-grade students recognized that if they did not take algebra they would not be able to take other mathematics classes in the future.

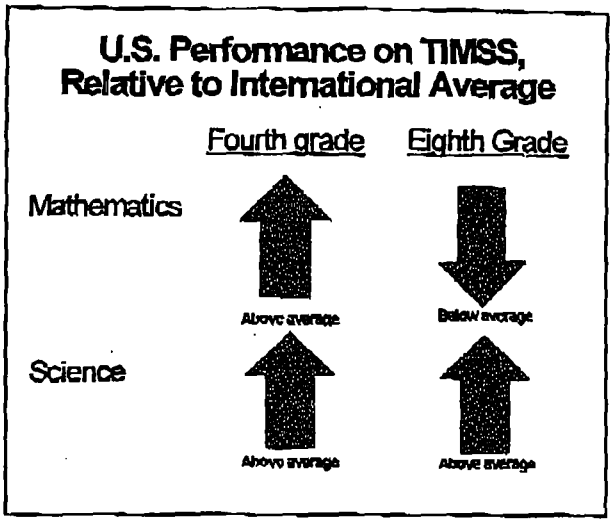
Parent and teacher involvement may make a large difference in students' decisions about mathematics and science. According to the NACME survey, ninety-four percent of students indicated that their parent's or guardian's advice was important to them in deciding what they

would study in school, and 88 percent indicated their teachers' advice was important. Ninety-one percent of parents want their children to continue their education beyond high school. However, when 9th- through eleventh-graders were asked who decided which mathematics classes they would take, seventy-nine percent indicate that they had made the decision by themselves.

Analysis of the NELS data indicates that students with greater levels of parental involvement are more likely to take advanced mathematics courses. Analysis of the course-taking patterns of the NELS students who were in 8th-grade in 1988 reveals that regardless of whether the level of parent involvement was reported by the student, the parent, or the teacher, higher levels of parental involvement were consistently associated with higher likelihoods of taking rigorous mathematics courses. While only 8 percent of those students who said that they did not discuss programs at school with their parents took algebra I by the 8th grade, 17 percent of those who said that they discussed school programs three or more times during the previous semester took algebra I by the 8th grade. Students who had parents or teachers who said that there were greater levels of parental involvement were also more likely to take advanced courses. Thirty-seven percent of those students whose parents said that they rarely talked to their child about high school plans took geometry by the 10th grade, while 48 percent of those students whose parents said they regularly spoke to the child about high school plans took geometry by the 10th grade. While 27 percent of students whose teachers said their parents were not involved took geometry by the 10th grade, a full 63 percent of the students whose teachers said that their parents were very involved took geometry by the 10th grade.

Mathematics in the U.S. Today

International Comparisons of Middle School Mathematics and Science Proficiency



Recent findings from the Third International Mathematics and Science Study (TIMSS), indicate that the mathematics curriculum from grades five through eight may be a weak link in the U. S. educational system. Newly available data from TIMSS (the most comprehensive international comparison of schools and students ever undertaken) reveal that U.S. 4th graders score above the international average in both mathematics and science. Among 25 other participating nations, only Korea performed better than the U.S. in 4th grade science, and only 7 of the 25 other countries did better than the U.S. in 4th grade mathematics. These findings are in contrast to earlier findings from TIMSS that indicate that U.S. 8th graders perform slightly below the international average in mathematics, and only slightly above the international average in science. In fact, only one country--the U.S. in mathematics--falls from above the international average at 4th grade to below the international average at 8th grade.

The U.S. expects less of its middle school and junior high students compared to high performing nations. TIMSS data suggest that one reason U.S. students do less well at 8th grade is that the middle school mathematics curriculum in the U.S. is significantly less challenging than the curricula used in other countries. In Germany and Japan, virtually all students in grades 5 through 8 move beyond arithmetic to the foundations of algebra and geometry. By 8th grade, mathematics courses in virtually all other countries participating in TIMSS include significant algebra and geometry, while in the U.S., only students in college-preparatory classes receive significant exposure to algebra, and very few students study geometry. As a result, the content taught in U.S. 8th grade mathematics classrooms is usually at a 7th-grade level compared to the 40 other nations in the TIMSS study.

TIMSS also found that U.S. mathematics classes require students to engage in less high-level mathematical thought and solve fewer multi-step problems than classes in Germany and Japan. A U.S. mathematics teacher's typical goal is to teach students the mechanics of solving a problem versus understanding the concepts behind it, while a Japanese teacher's goal is to help them learn the basics as well as understand the relevant mathematical concepts. In a typical U.S. classroom, students follow the teacher as he or she leads them through solutions to mathematics

problems. In Japan, students are asked to solve problems, present them to the class, and describe how they approached the problem to increase their own understanding.

How Does Our Curriculum Compare Internationally?

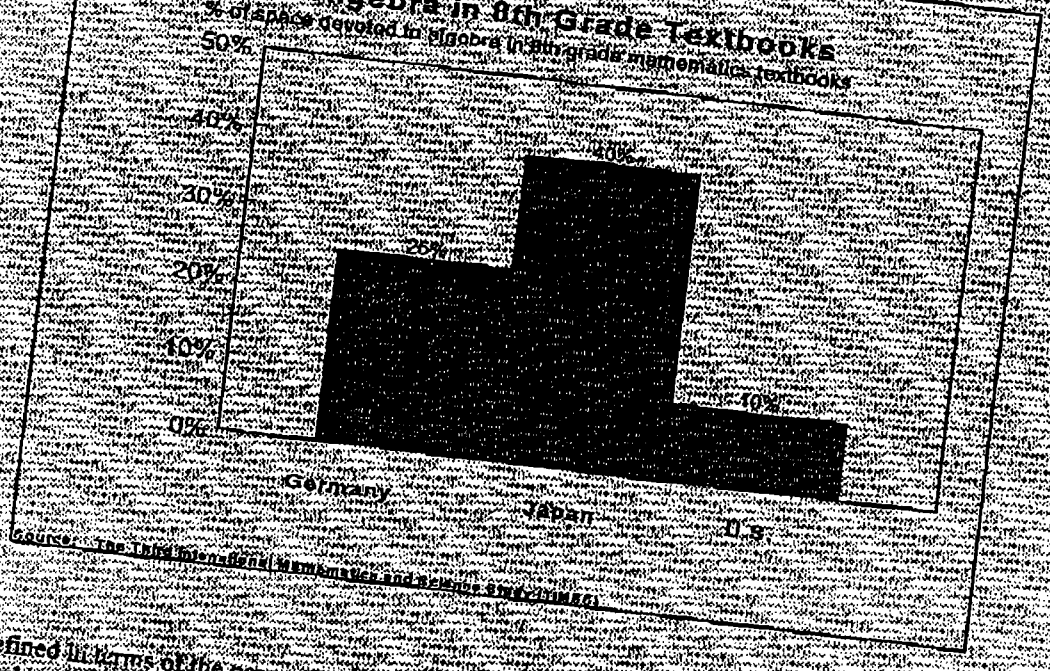
The 8th grade mathematics curriculum in both Germany and Japan is more advanced than in the United States. The TIMSS analysis of U.S. curricula examined both what is in textbooks and how it is implemented in classrooms.

An analysis of curriculum in the U.S. and other countries, found that algebra and geometry occupy more space[1] in German and Japanese textbooks than do the textbooks used by a majority of U.S. 8th graders (Figure 6).

Analyses of implementation of curriculum make clear that in the middle school years, the U.S. stays focused on arithmetic. For example, 40 percent of U.S. 8th grade mathematics lessons included arithmetic topics, whereas only 13 percent of Germany's and 0 percent of Japan's lessons at the 8th grade level included these topics. The major focus of curriculum taught in these countries is on algebra and geometry.

Figure 6

Algebra in 8th Grade Textbooks



Source: The Third International Mathematics and Science Study (TIMSS)

[1]Space is defined in terms of the percentage of a textbook or guidebook that is devoted to particular topics/blocks. Topics include such items as formulas, geometry, numbers, estimation. Blocks are sub-units of topics that are parts of a textbook and which might include individual pedagogical suggestions, individual examples, individual testing, narrative blocks, graphic blocks, suggested activities, and mathematical problems.

Promising Practices

In many places across the country, there are promising programs underway that focus on improving student achievement in mathematics and science. Many of these are greatly expanding the numbers of students taking rigorous courses in mathematics and science, and are finding that students are doing quite well. While recognizing that there is no one formula to success, we have highlighted a number of places that demonstrate effective strategies. We hope that these examples will be useful to you as you plan efforts to improve mathematics and science education for students in your community and across the nation.

Preparing for success: The Algebra Project, supported by the National Science Foundation (NSF) and directed by Robert Moses, addresses equity of opportunity by helping 6th, 7th, and 8th graders in inner city and rural areas gain an understanding of challenging mathematics. Serving over 40,000 traditionally low-income and minority middle school students, the Algebra Project is based on the conviction that all students can learn algebra given the proper context. An essential first step is that all students study algebra as early as possible to ensure their access to a college preparatory high school curriculum.

The project assists students in 22 urban and rural sites in 13 states to succeed in challenging high school mathematics courses by introducing rigorous mathematics concepts in the 6th grade, creating a foundation to build upon throughout the middle school years. The project has been successful in helping traditionally underserved students complete algebra I by the 8th or 9th grades, and either pre-calculus or calculus by the 12th grade utilizing a variety of strategies. The project places young college-age students in schools to provide extra assistance. In addition, the project provides after-school activities; and provides teacher professional development in examining the curriculum and beliefs about how it should be taught.

The Algebra Project has had important effects for communities. For instance, in the Mississippi Delta and in Jackson, Mississippi, the project showed positive short term effects. Additionally, an evaluation team, comprised of education experts from across the country, found evidence of positive outcomes in teaching, student attitudes about and engagement in mathematical ideas, and community involvement.

Taking the right courses: In 1990, the College Board launched EQUITY 2000 to increase minority enrollment in college preparatory mathematics courses. Originally piloted in six communities, EQUITY 2000 requires participating school districts to phase out lower-level mathematics and require all students to take a college preparatory curriculum--beginning with algebra and geometry. EQUITY 2000 influences policies, curricula and student academic development at all grade levels, with a particular focus on grades six through nine--critical years for mathematics education during which key decisions are made about which courses students should take and how they should begin planning for education and careers beyond high school.

The project provides on-going professional development to help teachers work with heterogeneous ability classes, encourages and supports parents to become advocates on behalf of their children, helps schools establish support services for students who need extra time and effort to learn challenging content, and trains administrators and teachers to use student enrollment and achievement data to drive school-based decision-making.

Finally, EQUITY 2000 has made increased parental involvement a priority because it recognizes the important role that parents play in nurturing and reinforcing their children's desire to attend college. It has sponsored Saturday and summer academies on college campuses for entire families. The program also sponsors Family Math nights in which parents and students learn mathematics concepts together.

An analysis of results at the six pilot sites found that:

- All sites dramatically increased the percentage of students enrolled in algebra I by the 9th grade, and in three pilot districts, all 9th graders enrolled in algebra I.

- The percentage of students passing algebra I did not decline significantly, and in some cases rose, as more students from the discontinued lower tracks began enrolling in algebra classes.

Advanced Placement Participation Rising in South Carolina and Texas. The College Board's Advanced Placement (AP) Program was started nearly four decades ago to enable students to complete college-level studies while still in high school and to obtain college credit or placement. Today more than 500,000 students in about half of the nation's high schools take at least one AP course, and those courses are widely recognized as setting the standard for high levels of academic achievement in high school. Dramatically increased participation in Advanced Placement courses in South Carolina and Texas illustrate the success of AP-based reform initiatives in two states.

South Carolina: With former-Governor Riley's school reform package of 1984, South Carolina became one of the first states to legislate funding and other actions to boost participation in AP. Actions included state appropriations to train AP teachers and to help pay for AP exams, as well as a requirement that public colleges accept AP courses if the student scored 3 or higher on the exam. As a result, from 1984 to 1997 South Carolina experienced:

- An increase in the number of students taking AP exams from 2,799 to 9,748.
- An increase in the number of AP exams from 3,461 to 14,890, with the mean grade remaining stable at approximately 2.7 - 2.8.
- An increase in the number of AP science exams (Biology, Chemistry, Physics) from 27 to 2,414.
- An increase in the number of AP math exams (Calculus AB and BC) from 46 to 2,767.

- Ninety-three percent of all the public high schools in the state participating in AP(184 of 197 public high schools).
- AP participation rates above the national average.

AP Exams Taken
(Eleventh and Twelfth Graders)

	1984	1997	Percent increase
South Carolina	3,461	14,890	77 percent
National	223,888	843,399	73 percent

Sources: College Board. *Advanced Placement Program, National and South Carolina Summary Reports, 1984 - 1997.*

Texas: The Advanced Placement Incentives program was developed in the Dallas, Texas area by the O'Donnell Foundation in reaction to the low rates of college attendance and poor college preparation of low-income and minority students. The Advanced Placement Incentives program addresses shortfalls in both the supply and demand for AP courses in math, science, and the arts, by providing performance-based financial incentives to teachers, school and students. Teachers are given financial incentives as well as registration and fees for attending College Board AP teacher training during the summer, and to begin to teach AP courses. Students who complete the Advanced Placement course may take the AP exam at half-cost (the total cost for an AP exam is about $73), and those who score a three or better (on a five point scale) are given a financial incentive and reimbursed for the cost of the exam.

In five years of operation in nine Texas public schools the O'Donnell foundation reports that:

- In the first year of the program 97 students took AP exams, and 52 received a three or better. In the fifth year of operation 1,099 students took AP exams, and 521 received a score of three or better.
- AP participation increased among female students in areas in which females are traditionally under represented, with 19 female students taking AP exams in math, science, or computer science during the program's first year, and 240 female students (compared to 272 male students) doing so in the program's fifth year.
- Minority participation increased, from 7 African-American or Hispanic students taking AP exams during the program's first year, to 116 in the program's fifth year.

Instructional Reform in Mathematics. Sponsored by the University of Pittsburgh's Learning Research and Development Center, the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project is designed to respond to low levels of student participation and the inadequacy of student performance in mathematics. QUASAR is a practical school demonstration project for urban middle schools that fosters the development and implementation of enhanced mathematics instructional programs in economically disadvantaged communities. The program's key principles are that all students are able to learn a broad range of mathematical content, acquire a deeper and more meaningful understanding of mathematical ideas,

and demonstrate proficiency in mathematical reasoning and complex problem solving.

IN QUASAR schools, teams of mathematics teachers, school administrators and "resource partners"-- generally mathematics educators from local universities-- collaborate to develop, implement, and refine mathematics instructional programs. All project schools have eliminated most forms of academic tracking, and have emphasized deeper student understanding and high-level thinking and reasoning for all students. While there is variation across the sites in curricula, teaching strategies, and approaches to professional development, all QUASAR sites included extensive attention to professional development and teacher support. Additionally, the University of Pittsburgh's Learning Research and Development Center provides the schools with ongoing support and updated information on progress.

Program data indicate that QUASAR schools build the capacity of teachers to improve the quality of their mathematics instruction and to increase the capacity of students to think, reason, solve complex problems, and communicate mathematically. Students in QUASAR schools, particularly those who are from minority groups and those with limited English proficiency, have increased their understandings of important mathematical ideas across a range of content topic areas. Additionally, QUASAR students in grade 8 performed as well as students on basic and traditional items of the 1992 NAEP Mathematics Assessment, and above their peers on less traditional middle school mathematics content.

Standards-based Reform. The New York Regents Exam has spurred thousands more high school students to take and pass college-preparatory mathematics courses. In 1993 then-New York-Chancellor Ramon Cortines required all students to take tougher Regents-level mathematics and science courses traditionally reserved for college-bound students. Beginning in 1995, the state required that all students take Regents-level classes. The number of Hispanic and black students who passed the science portion of the Regents Exam more than doubled from the previous year. Since then, the state has decided to require that all students take and pass the Regents Exams . In addition, Commissioner of Education Richard Mills has recently called for an increase in the rigor of the state's requirements for graduation from high school, including adding another year of both mathematics and science to the current two years required in each.

Living Up to Our Potential: The First in the World Consortium, Chicago, Illinois. Twenty school districts from Chicago's North Shore joined forces in 1995 to meet the challenge of providing their students with a world class education in mathematics and science. Their first challenge was to determine what a "world class" education looked like, measure their current performance against that benchmark, and develop an improvement strategy.

The Consortium's efforts were directed toward three objectives: benchmarking performance against international standards in mathematics and science, using the Third International Mathematics and Science Study; creating a forum to clarify world-class education standards for business leaders, policy makers, educators, and community members; and establishing a network of learning communities involving educators, parents, and community leaders within the Consortium school

districts and beyond.

The districts in the First in the World Consortium took the TIMSS assessment in Spring 1996 at the 4th, 8th, and 12th grade level. Their 8th grade results placed them among the top performing countries in the world at the 4th and 8th grades, well exceeding the United States' performance. In addition:

- Fifty percent of their 8th grade students took algebra or geometry compared to 25 percent of students nationally who take algebra;
- The Consortium had high expectations for students and teachers; and
- Gained broad-based community support for improved student performance.

However, the First in the World Consortium is not resting on their success; in fact they have created teacher learning networks to strengthen curriculum standards, models of instruction, assessment, and use of technology. This "community of learners" approach promotes teacher participation and provides a context for long-term commitment to the consortium's goals and to growth in student learning.

Although the First in the World Consortium is at an advantage in terms of its resources, its willingness to identify its weaknesses and address them has distinguished its efforts. The consortium identifies both state and federal support as helping it focus on its goals. These experiences emphasize that, when given the opportunity, U.S. students can perform as well as, or better than, students in any part of the world.

Next Steps

Six things educators, policymakers and community members can do:

1. Provide all students the opportunity to take algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in all four years of high school.

2. Build the groundwork for success in algebra by providing a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares students for the transition to algebra.

3. Ensure that all students, parents, teachers, and counselors understand the importance of students' early study of algebra as well as continued study of rigorous mathematics and science in high school to their future college and career opportunities.

4. Prepare teachers of mathematics to teach rigorous mathematics by providing teacher preparation and professional development opportunities that increases teachers knowledge and skills in mathematics and the teaching of mathematics.

5. Support mathematics achievement outside the classroom such as math clubs, tutoring and job shadowing for students who may need extra help to ensure that they can achieve at high levels.

6. Support parent involvement in their children's mathematics education.

Six things parents can do:

1. Discuss your children's mathematics homework with them.

2. Visit your children's mathematics teacher to find out what your children are learning and how you can help.

3. Insist that your children be enrolled in algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade and more advanced math and science courses in high school so they can keep all of their future options open.

4. Ensure that your children are gaining the groundwork for success in algebra through a rigorous curriculum in grades K-7 that moves beyond arithmetic and prepares them for the transition to algebra.

5. Help your children understand the importance of taking challenging mathematics and science courses to their future by visiting colleges, familiarizing them with college requirements, and

exploring financial aid options available to students.

6. Show the importance of mathematics to career choices by talking with your children about the use of mathematics in your work or the work of adults they know.

Resources

Everson, Howard T. and Marlene Dunham. *"Signs of Success—EQUITY 2000, Preliminary Evidence of Effectiveness."* New York, NY: The College Board, 1966.

Hawes, Mark, Kimmelman, Paul, and Kroeze, David. "Becoming 'First in the World' in Math and Science: Moving High Expectations and Promising Practices to Scale." *Phi Delta Kappan*, Volume 79, Number 1, September 1997.

Jones, Vinetta C. "What A Difference A Standard Makes." In D. Bartels & J. Opert Sandler (Eds.), *This Year in Science: Implementing Science Education Reform."* Washington, DC: American Association for the Advancement of Science, in press.

Levy, Frank and Richard Murnane. *Teaching the New Basic Skills: Principles for Educating Children to Thrive in a Changing Economy*, New York: The Free Press, 1996.

Lynn, Leon and Wheelock, Anne. "Making Detracking Work," *The Harvard Education Letter*, Cambridge: Harvard Graduate School of Education, January/February 1997.

National Action Council for Minorities in Engineering. *Uninformed Decisions: A Survey of Children and Parents about Math and Science*, Conducted for National Action Council for Minorities in Engineering, By Louis Harris and Associates, 1995.

The National Commission on Teaching and America's Future. *What Matters Most: Teaching for America's Future*, September, 1996.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*, Reston, VA: Author, 1989.

Porter, Andrew. "The Effects of Upgrading Policies on High School Mathematics and Science." Consortium for Policy Research in Education, 1997, and in Brookings Papers on Education Policy, 1997.

Schmidt, William H., McNight, Curtis C., and Raizen, Senta A. *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, East Lansing, MI: U.S. National Center for the Third International Mathematics and Science Study, Michigan State University, 1996.

U.S. Department of Education. National Center for Education Statistics. *Education and the Economy: An Indicators Report*, Washington, D.C.: U.S. Government Printing Office, 1997.

U.S. Department of Education. National Center for Education Statistics. *NAEP Facts: Eighth-Grade Algebra course-Taking and Mathematics Proficiency*, Washington, D.C.: U.S.

Government Printing Office, 1996.

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, Washington, D.C.: U.S. Government Printing Office, 1996.

U.S. Department of Education. National Center for Education Statistics. *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International* Context, Washington, D.C.: U.S. Government Printing Office, 1997.

U.S. Department of Education. National Center for Education Statistics. *Statistics in Brief: Changes in Math Proficiency Between 8th and 10th Grades*, Washington, D.C.: U.S. Government Printing Office, 1996.

U.S. Department of Education. Planning and Evaluation Service. *Analysis of NELS:88 Follow-Up Data: Factors That Affect College Enrollment*, Forthcoming.

U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook*, Washington, D.C.: U.S. Government Printing Office, 1997.

Appendix

The NELS:88 data. The National Education Longitudinal Study of 1988 (NELS:88) initially surveyed a nationally representative sample of 26,000 public and private school 8th grade students in 1988. The data collected include responses to student questionnaires, scores on standardized achievement tests, high school transcripts, and interviews with parents and teachers. Since the initial survey in 1988, the students have been resurveyed every two years, with the most recent data available gathered two years after their scheduled high school graduation in 1994. The analyses in this report are based on a sub-sample of over 13,000 individuals from whom data were collected in all three follow-up surveys. Analysis of course-taking patterns is based on student reports of 8th-grade course-taking and high school transcript data. The actual titles of mathematics courses as they appear on the transcripts may vary, despite covering similar content (for example, geometric concepts); accordingly, we have attempted to include all courses covering similar content under traditional course names (i.e. "geometry," "algebra II") reflective of their content.