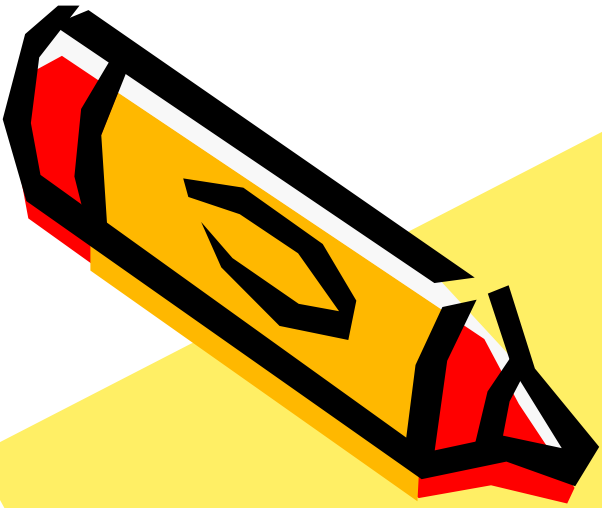
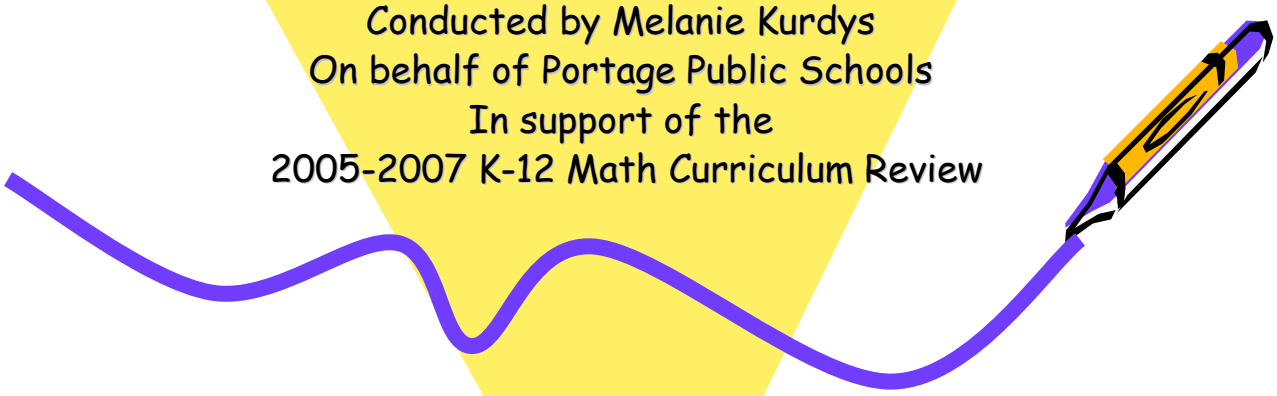


Math Curriculum Review "After High School" Math Expectations

Final Report April 2006

Conducted by Melanie Kurdys
On behalf of Portage Public Schools
In support of the
2005-2007 K-12 Math Curriculum Review



MATH CURRICULUM REVIEW
RESEARCH ON
"AFTER HIGH SCHOOL" MATH EXPECTATIONS
April 2006

Executive Summary

In October of 2005, Portage Public Schools Curriculum Director initiated a research project on the mathematics knowledge needed by high school graduates, primarily as they advance to higher education. This research was in support of the K-12 Math Curriculum Review underway 2005-2007.

The research provides compelling evidence that advanced math, specifically Algebra II, is critical for all students who intend to pursue education beyond high school. The data also shows that many Portage college-bound students do not learn Algebra well enough in high school to be adequately prepared. Furthermore, a brief review of the job market indicates that many entry level jobs and technical positions rely on more than just basic arithmetic. All students need to know and understand math through Algebra. The State of Michigan recently concurred with the passage of Math High School requirements through Algebra II for all students. Robert Moses*, among others, views "*algebra for all students* as a civil right." (US Department of Education ED-99-CO-0160)

The task ahead is a challenging one. Fortunately, the universities and colleges in Michigan are very willing to share their information and ideas in helping Portage structure a math curriculum and educational environment that will best serve the students. Consistent suggestions from university faculty included:

- All students need to develop a strong, basic math understanding
- Students need to know math facts and math vocabulary
- Calculators should be used but should not be a crutch
- Students need to learn and understand Algebra
- Testing is an important tool to assess student learning
- Partner with the universities to continue improving math education.

* Robert Moses taught mathematics at the Horace Mann School in New York (1958-1961). Moses left teaching to work full-time in the civil rights movement. In 1982 Moses was awarded a MacArthur Fellowship and over the next five years he developed the Algebra Project. Moses currently teaches algebra and geometry to high school students at Lanier High School in Jackson, Mississippi. According to a recent *USA Today* article, Moses' organizational and motivational skills are combined as a teacher to lead children to believe he lets them *play* in math. But Moses' deeper belief is that math literacy -- particularly algebra -- is the key to economic access.

MATH CURRICULUM REVIEW
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MATH CURRICULUM REVIEW
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FINAL REPORT

Background

It has been reported that as many as 90% of Portage high school graduates continue on to higher education. Since this number is reported by students on a voluntary basis and represents their plans rather than on confirmed enrollments, the number could arguably be lower. However, it is generally agreed that a significant majority of students do go on to higher education. Based on student reported data, over 90% of Portage graduates going on in their schooling attend one of five colleges. The approximate distribution of 2005 graduates among these five schools is as follows:

	Approximate 2005 Distribution
- Kalamazoo Valley Community College (KVCC)	35%
- Western Michigan University (WMU)	25%
- Grand Valley State University (GVSU)	5%
- Michigan State University (MSU)	20%
- University of Michigan (UM)	15%

There is considerable diversity of choice among the remaining Portage college-bound students, although most choices are similar in characteristics to one of these five. A notable exception is Universal Technical Institute, a nationally recognized automotive repair school which specializes in manufacturer specific advanced training. UTI has been selected by a number of our graduates over the last few years. Therefore, UTI was included in this research.

Since the majority of Portage students do go on to higher education, the primary focus was placed on determining expectations of these institutions for math preparation. Some effort was placed on evaluating math expectations for students who go directly into the workplace.

Methodology

Research began with a thorough review of the admissions information posted on the web site of each of the selected learning institutions. Contact was initially made with the admissions department. After gathering information about admissions, each school provided a referral to an instructor in the mathematics department. Once the math instructor was interviewed, a written summary was emailed for verification of quotes, intents and facts. The final version of each of these contacts is included in the report along with names, job titles and phone numbers. The last contact was a request, usually to an Information Technology department, for data regarding math placement trends over the last 5 years.

All schools contacted were very cooperative and enthusiastic in their willingness to support the work of this Math Curriculum Review Team. Each contact was asked and agreed to be available for follow-up questions or clarifications as needed. As a courtesy, a follow-up letter of how their information was used and the final recommendations for our math curriculum should be supplied to the contacts.

Internet web sites used for additional information included www.ACT.org, www.achieve.org and www.edtrust.org .

Characteristics of the Schools and Recommended Math Competencies

The six post-K-12 schools included in the study provide a broad range of opportunity for Portage students:

- KVCC has no academic entrance requirements. They offer math courses which range from basic arithmetic through Calculus 3, Differential Equations and Linear Algebra. KVCC offers Certificates of Achievement, Certificate and Associate Degrees, known as "Go to work" degrees. Some of these require math credits and many do not. An extensive credit transfer program to 4-year universities has been developed by KVCC for use by their students. The transfer guidelines are developed and approved in partnership with the specific universities.

- UTI requires students to have a high school diploma or GED. Math related high school courses recommended include Algebra, physics and computers. The time it takes to graduate depends on the person since attendance can be part-time. Credits earned are transferable to Bachelor degrees at Ferris State University and University of Phoenix, although many graduates go directly to work.

- WMU and GVSU are considered "third tier"* universities on a national basis. Their entrance guidelines include three years of math and a math ACT score of 20. Both universities require all students to meet a math requirement as part of their diploma program.

- MSU is considered a "second tier"* university. Incoming freshmen should have taken at least three years of math in high school, including algebra and geometry, and have a math ACT score of 21 or higher.

- UM is considered a "first tier"* school. Incoming freshmen should have taken at least four years of high school math and either have taken or be ready to take calculus. The math ACT score guideline is 26.

Cross-Reference of Post K-12 Schools Entrance Requirements***

	KVCC	WMU	GVSU	MSU	UM	UTI
Minimum yrs of HS math	NA	3	3	3	4	
Algebra & Geometry	Yes	Yes	Yes	Yes	Yes	Yes
Algebra II		Yes	Yes	Yes	Yes	?
Pre-calc		Opt	Opt	Yes	Yes	NA
Calc		Opt	Opt	Opt	Rcmmd	NA
Other recommendations			4 yrs	4 yrs		NA
Placement Exam	Yes	Yes	Yes	Yes	Yes	NA
ACT Score guideline**	NA	20-25	20-25	21-26	26-30	NA

*U.S. News & World Report publishes an annual assessment of 1400 colleges and universities. Their ranking process considers student selectivity as one of the top five assessment criteria. When evaluating what these sample universities expect from incoming freshmen, student selectivity is a relevant factor. In general, "first tier" universities have higher student selectivity than "second tier" than "third tier". There is no judgment implied in this report regarding the quality of education achievable by students who attend these universities

**The ACT scores noted are taken from the U. S. News & World Report reference. The first number reflects the 25th percentile and the second, the 75th percentile.

***Post K-12 schools use "Algebra, geometry" references to refer to a knowledge base. No inference is made to learning the material in traditional or integrated courses.

Math Entrance Assessments

Once students are accepted to a college or university, a process begins to help place them in the appropriate math class depending on their knowledge and the school's requirements for degree programs. Math assessments are used to help students enroll in courses in which they are most likely to achieve academic success. In most schools, students can choose to enroll in an easier class than the one they place into. Some schools allow student to place in more difficult classes if they choose.

The five colleges/universities each have math entrance assessment processes to place students into the math class appropriate to their ability level. Not all KVCC degrees have math requirements. The universities have a math requirement for degree programs, so all incoming students must go through the math placement process. This does not mean however, that all freshmen are required to take a math course as they may "test out". Some students choose to defer their math requirement to a later year.

WMU and GVSU currently use ACT scores and high school math classes taken to determine placement. WMU is developing an assessment which can be taken online. GVSU has an exam students can take if they disagree with the recommended course placement.

UM and MSU both have online exams. The MSU exam is less than 30 questions and generally assesses the students' knowledge level. The UM exam is designed to answer the question, "Is this student ready for calculus or not?"

The KVCC exam is quite different from the others. It is an interactive, computerized exam. The student is presented with the first problem, an Algebra I level. If the student answers correctly, the computer then presents a more difficult question. If the student answers incorrectly, an easier question is presented. Using this process through about 10 questions, a course recommendation is made. The admissions counselors and the Math Department Chair at KVCC all believe this approach is very effective.

"Remedial" Definitions and Comparisons

Since the schools vary greatly in their expectations for incoming freshmen, the specific course levels defined as "remedial" vary considerably. They do agree, however, that in general, courses which are considered remedial require time and cost money and the credits earned do not apply to credits needed for graduation.

KVCC has developed a course cross reference for the major universities. The cross reference specifies which KVCC course transfers for credit to each school. The universities verify this reference. Using the university confirmed cross-reference, a reasonable course comparison can be done.

MATH COURSE COMPARISONS BY SCHOOL
(Based on KVCC course definitions and credit transfers)

COURSE NAME	Course Number by School KVCC	WMU	GVSU	MSU	UM
Limited Algebra					
Conceptual Arithmetic	79	no credit	no credit	no credit	no credit
Basic Arithmetic	80	no credit	no credit	no credit	no credit
Basic Technical Math	92	no credit	no credit	no credit	no credit
Pre-Algebra	93	no credit	no credit	no credit	no credit
Basic Arith / PreAlgebra	94	1090	no credit	no credit	no credit
Fundamentals of Algebra	96	1100	97	no credit	no credit
Health Careers Math	100	no credit	no credit	no credit	no credit
Technical Math	106	mth cr	no credit	no credit	no credit
Algebra Based					
Math Ideas	114	1140	131	mth cr	no credit
Intermediate Algebra	116	1110	110	1825	no credit
Finite Math	120	1160	mth cr	mth cr	mth cr
Nmbrs cncpts Elem/MS teach	140	1500	222	no credit	385
Geometry Elem/MS Teach	142	1510	221	mth cr	mth cr
College Algebra	150	mth cr	122	103	103
Cllg Algebra/Applis&Tech	151	mth cr	122	mth cr	pending
Algebra Proficient					
Trig	152	1180	123	114	105
PreCalc	156	1180	122/123	116	pending
Applied Calc	158	2000	125	132	mth cr
Calc 1 & Analytic Geometry	160	1220	201	132	115
Calc 2 & Analytic Geometry	162	1230	202	133	116
Calc 3 & Analytic Geometry	260	2720	203	234	215
Different'l Equa/Linear Algebra	264	3740	304	235	216

The courses listed in the “Limited Algebra” category are uniformly considered remedial. A Fundamentals of Algebra course is listed which correlates to the first high school Algebra course. The KVCC course descriptions are included in this report to facilitate specific comparisons.

The courses listed in “Algebra Proficient” are the college level courses beyond Algebra. “Algebra Proficient” means “Ready for Trig & Calculus”. These courses are consistently considered NOT remedial. (Exception: UM considers trigonometry remedial, for students in Engineering or Math fields).

The Courses listed in “Algebra Based” are mixed in terms of credit versus no-credit versus diploma applicable. In U. S. Department of Education studies as well as studies conducted by the American Mathematical Society, pre-calculus courses are considered remedial. (The Education Trust, “Thinking K-16” 2002) Refer to the specific school’s web information to determine which are considered remedial at that school.

These classifications will be used to support further analysis.

Using the ACT ranges specified by WMU and GVSU, students place into their first math class as shown on this table. MSU does not use ACT for placement, but they have found that students who score 18 or lower on math ACT typically place below intermediate algebra.

ACT Score and Resulting Course-level Placement

	ACT	WMU	GVSU	MSU	UM	PPS AVG
Limited Algebra		19-	18-	18-		
Algebra Based	22	20-23	19-25			22-23
Algebra Proficient		24+	26+			
Admission guideline		20-25	20-25	21-26	26-30	

ACT conducted research to create benchmark scores for each subject area where students have a 75% chance of getting a C or better in the first credit bearing college course. In math, this score was determined to be 22 to enter a college level algebra course. (ACT Research Report 2005-3) MSU has determined that 20% of students, who place into their algebra course, fail the course and do not graduate within 6 years. However, this means 80% who place into MSU Algebra do pass the course. These statistics and studies together confirm the finding that an ACT score of 22 places a student squarely in the Algebra Based set of courses with a good probability of success at that level.

According to Standards & Poor's School Matters website, Portage students who have taken the ACT have averaged a score of 22 and 23 on the math ACT every year since 2002. Approximately 65% of Portage students take the ACT.

When students take the ACT, they are asked to specify which math courses they have taken. ACT and The Education Trust published the results of an analysis of ACT scores, student performance and high school courses taken in a book "On Course for Success". (This information is available online at www.act.org and www.edtrust.org). Their analysis showed the following:

High School Courses Taken	Average Math ACT
- Less than three years of HS math	17.2
- Algebra I, II and Geometry	17.7
- plus Trigonometry	20.3
- plus another advanced math	22.1

ACT also developed a guideline, the "ACT College Readiness Standards for Mathematics", with the corresponding predicted ACT score which can be used in high school course development and evaluation.

College Readiness Standards — Mathematics				
	Basic Operations & Applications	**Probability, Statistics, & Data Analysis**	**Numbers: Concepts & Properties**	**Expressions, Equations, & Inequalities**
13–15	Perform one-operation computation with whole numbers and decimals Solve problems in one or two steps using whole numbers Perform common conversions (e.g., inches to feet or hours to minutes)	Calculate the average of a list of positive whole numbers Perform a single computation using information from a table or chart	Recognize equivalent fractions and fractions in lowest terms	Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$) Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals
16–19	Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent Solve some routine two-step arithmetic problems	Calculate the average of a list of numbers Calculate the average, given the number of data values and the sum of the data values Read tables and graphs Perform computations on data from tables and graphs Use the relationship between the probability of an event and the probability of its complement	Recognize one-digit factors of a number Identify a digit's place value	Substitute whole numbers for unknown quantities to evaluate expressions Solve one-step equations having integer or decimal answers Combine like terms (e.g., $2x + 5x$)
20–23 ***22**	Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average	Calculate the missing data value, given the average and all data values but one Translate from one representation of data to another (e.g., a bar graph to a circle graph) Determine the probability of a simple event Exhibit knowledge of simple counting techniques*	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor	Evaluate algebraic expressions by substituting integers for unknown quantities Add and subtract simple algebraic expressions Solve routine first-degree equations Perform straightforward word-to-symbol translations Multiply two binomials*
24–27	Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour)	Calculate the average, given the frequency counts of all the data values Manipulate data from tables and graphs Compute straightforward probabilities for common situations Use Venn diagrams in counting*	Find and use the least common multiple Order fractions Work with numerical factors Work with scientific notation Work with squares and square roots of numbers Work problems involving positive integer exponents* Work with cubes and cube roots of numbers* Determine when an expression is undefined* Exhibit some knowledge of the complex numbers†	Solve real-world problems using first-degree equations Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions) Identify solutions to simple quadratic equations Add, subtract, and multiply polynomials* Factor simple quadratics (e.g., the difference of squares and perfect square trinomials)* Solve first-degree inequalities that do not require reversing the inequality sign*
28–32 *	Solve word problems containing several rates, proportions, or percentages	Calculate or use a weighted average Interpret and use information from figures, tables, and graphs Apply counting techniques Compute a probability when the event and/or sample space are not given or obvious	Apply number properties involving prime factorization Apply number properties involving even/odd numbers and factors/multiples Apply number properties involving positive/negative numbers Apply rules of exponents Multiply two complex numbers†	Manipulate expressions and equations Write expressions, equations, and inequalities for common algebra settings Solve linear inequalities that require reversing the inequality sign Solve absolute value equations Solve quadratic equations Find solutions to systems of linear equations
33–36 †	Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings)	Distinguish between mean, median, and mode for a list of numbers Analyze and draw conclusions based on information from figures, tables, and graphs Exhibit knowledge of conditional and joint probability	Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers Exhibit knowledge of logarithms and geometric sequences Apply properties of complex numbers	Write expressions that require planning and/or manipulating to accurately model a situation Write equations and inequalities that require planning, manipulating, and/or solving Solve simple absolute value inequalities

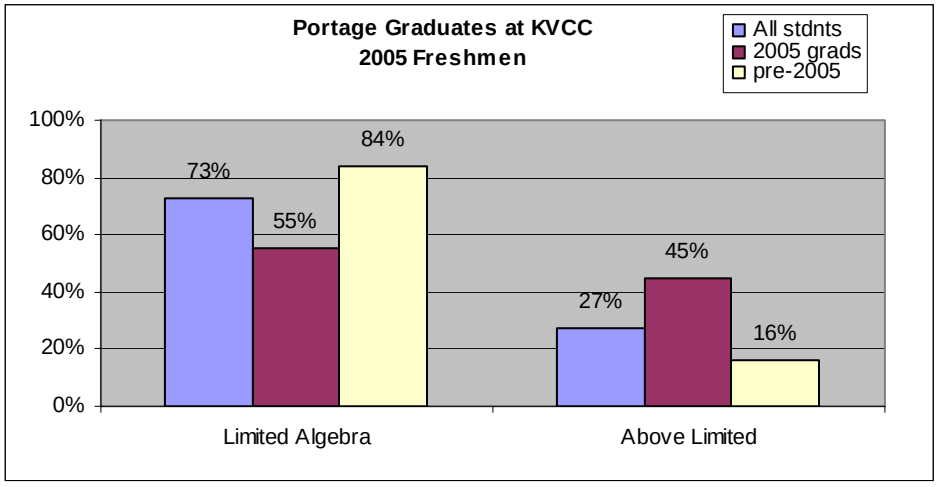
*** 22 - ACT Benchmark - Students have a 75% chance of a C or better in College Algebra**
22-23 - Portage average ACT Math score 2002-2004 (approximately 60% of students)
Below 20 usually places into "Limited Algebra", Over 26 is "Algebra Proficient" or "Calculus Ready"

College Readiness Standards — Mathematics (continued)

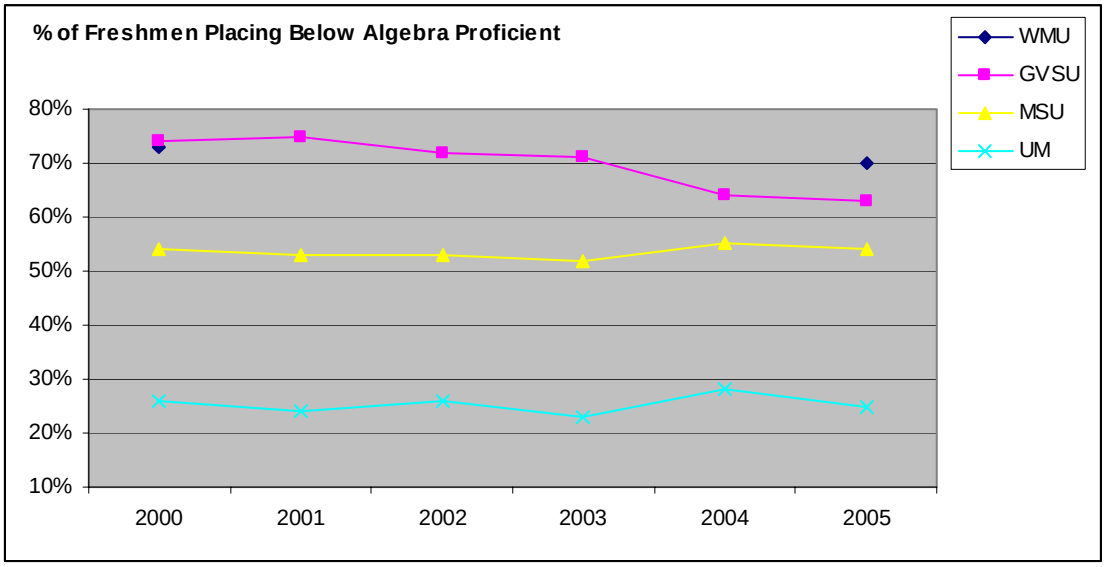
	Graphical Representations	Properties of Plane Figures	Measurement	Functions†
13–15	Identify the location of a point with a positive coordinate on the number line		Estimate or calculate the length of a line segment based on other lengths given on a geometric figure	
16–19	Locate points on the number line and in the first quadrant	Exhibit some knowledge of the angles associated with parallel lines	Compute the perimeter of polygons when all side lengths are given Compute the area of rectangles when whole number dimensions are given	
20–23 ***22**	Locate points in the coordinate plane Comprehend the concept of length on the number line* Exhibit knowledge of slope*	Find the measure of an angle using properties of parallel lines Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)	Compute the area and perimeter of triangles and rectangles in simple problems Use geometric formulas when all necessary information is given	Evaluate quadratic functions, expressed in function notation, at integer values
24–27	Identify the graph of a linear inequality on the number line* Determine the slope of a line from points or equations* Match linear graphs with their equations* Find the midpoint of a line segment*	Use several angle properties to find an unknown angle measure Recognize Pythagorean triples* Use properties of isosceles triangles*	Compute the area of triangles and rectangles when one or more additional simple steps are required Compute the area and circumference of circles after identifying necessary information Compute the perimeter of simple composite geometric figures with unknown side lengths*	Evaluate polynomial functions, expressed in function notation, at integer values Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths
28–32 *	Interpret and use information from graphs in the coordinate plane Match number line graphs with solution sets of linear inequalities Use the distance formula Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle)†	Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles Use the Pythagorean theorem	Use relationships involving area, perimeter, and volume of geometric figures to compute another measure	Evaluate composite functions at integer values Apply basic trigonometric ratios to solve right-triangle problems
33–36 †	Match number line graphs with solution sets of simple quadratic inequalities Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$ Solve problems integrating multiple algebraic and/or geometric concepts Analyze and draw conclusions based on information from graphs in the coordinate plane	Draw conclusions based on a set of conditions Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas Use relationships among angles, arcs, and distances in a circle	Use scale factors to determine the magnitude of a size change Compute the area of composite geometric figures when planning or visualization is required	Write an expression for the composite of two simple functions Use trigonometric concepts and basic identities to solve problems Exhibit knowledge of unit circle trigonometry Match graphs of basic trigonometric functions with their equations

*** 22 - ACT Benchmark - Students have a 75% chance of a C or better in College Algebra**
22-23 - Portage average ACT Math score 2002-2004 (approximately 60% of students)
Below 20 usually places into "Limited Algebra", Over 26 is "Algebra Proficient" or "Calculus Ready"

Statistics on Algebra Proficiency*



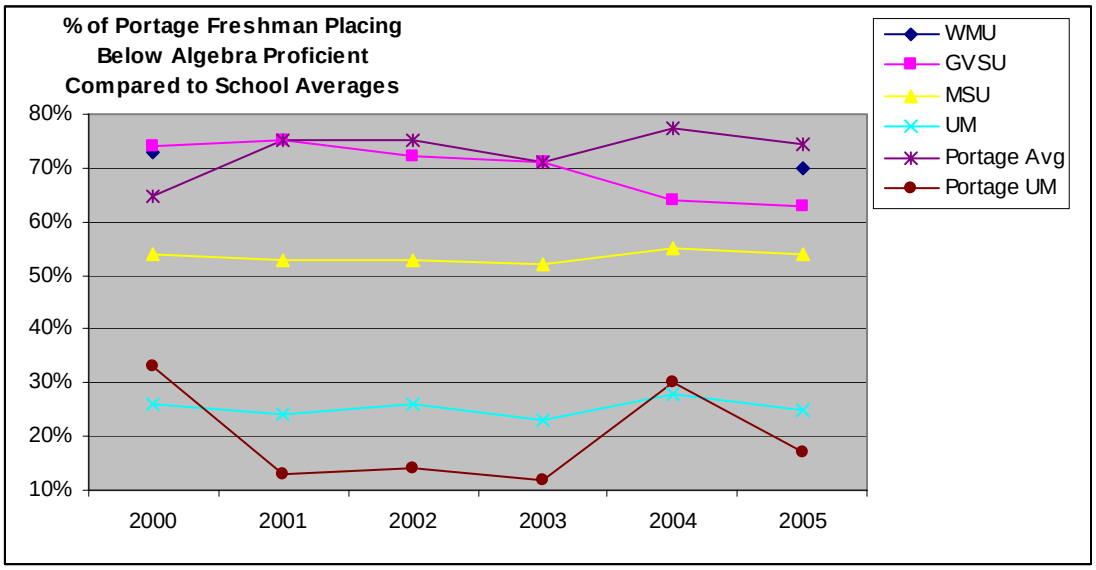
Most freshmen at KVCC place in the category "Limited Algebra", 73% in 2005. In 2005, of Portage graduates who entered KVCC as freshmen, approximately 60% were 2005 graduates and 40% graduated before 2005. 55% of 2005 Portage graduates placed in Limited Algebra, 45% placed above. 84% of pre-2005 graduates placed in Limited Algebra, 16% placed above. The KVCC Admissions Counselor suggested this disparity might be influenced by the currency of math instruction.



Above is a chart depicting the average trends of math placement in the four universities studied. Using "Algebra Proficiency" as the cut-off point, this chart shows the percent of incoming students who place in Limited Algebra and Algebra Based altogether. (WMU has only two data points, 2000 and 2005.) This data shows:

- GVSU has had the highest average rate of below Algebra proficiency but is noticing a declining trend
- UM has the lowest overall rate, probably due to student selectivity. approximately 25% of UM students place into Algebra based, (and 75% place into calculus or Algebra proficient)

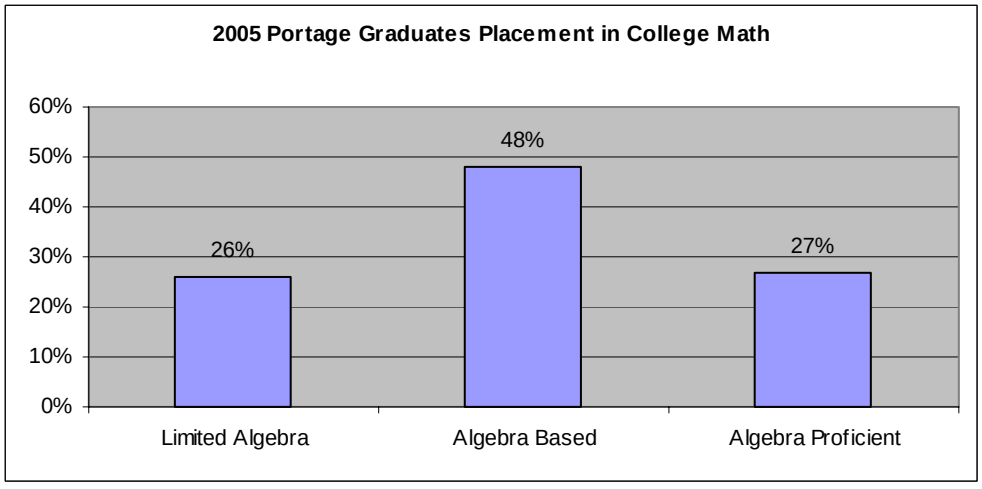
(*Data in this section was provided by the post K-12 schools representing course enrollments not assessment outcomes. Students could choose a different placement although it is unlikely they would choose a lower category of Algebra readiness. Summaries were done by the author.)



This chart is the same as the previous chart with the addition of Portage specific data. Since the UM numbers are significantly lower than the other three, two basis for comparison should be made, one focusing on UM averages and Portage students at UM, the second highlighting the Portage averages for the other three schools together. These comparisons show:

- fewer than average Portage students who go to UM place below Algebra proficient, (more than average place into calculus.)
- on average, more Portage students place below Algebra proficient at the other three universities, (WMU, GVSU, MSU)

As a percent of students by school, most Portage graduates at UM place predominately into Algebra Proficient. However, some Portage graduates attending the other three universities, WMU, GVSU & MSU, also place into Algebra proficient. The total distribution of math placement for Portage students is as follows:



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Overall, Portage graduates who go to college, place predominately into Algebra Based. This is consistent with the previous stated finding that the average Portage Math ACT score is 22/23, the same as the ACT Benchmark predicting 75% chance of earning a C or better in College Algebra. Interestingly, about the same number of Portage graduates placed below, in Limited Algebra, as above, Algebra Proficient. Approximately 25 of 2005 Portage graduates attended KAMSC, not a majority of the 27% Algebra Proficient. This suggests there is a math curricular program within Portage high schools which successfully prepares students for college calculus.

Expectations from the Business Community for High School Graduates

The American Diploma Project, 2002, documented math requirements for blue-collar jobs as part of their research. They found that tool & die makers and sheet metal workers require algebra, geometry, trigonometry and statistics. Machine operators at Eastman Chemical company need to be able to "add, subtract, multiply divide and simplify rational expressions" as well as "determine the perimeter and circumference of geometric shapes", skills covered in college-level algebra courses.

An article published in January 23, 2006 Business Week "Math will Rock your World" advocates "boosting the number of students who make it through calculus"…as well as "cultivating greater math savvy among the broader population to prepare it for a business world in which numbers will pop up continuously" and specifically, "extending the math curriculum to applied subjects such as statistics".

Quotes from various studies about workplace skills include:

> "Studies of the skill and knowledge that employers need in the workplace show with increasing clarity that these expectations look very much like those in higher education" (Somerville & Yi 2002.)
>
> "Just as we educators have learned that courses like Algebra II are the gatekeepers to higher education, we must now come to understand that they are gatekeepers to well-paying jobs as well" (Haycock 2003)
>
> "No longer do students planning to go to work after high school need a different and less rigorous curriculum than those planning to go to college" (American Diploma Project 2004)
>
> In a survey of "high school graduates who went directly to work, 41% say there are gaps in their math preparation. When asked which subject they wish schools had done a better job preparing them, most said math. 84% said they believed they will need more formal education or training to achieve what they hope for in life." (Rising to the Challenge, Achieve, Inc. February 2005)

Kalamazoo Regional Chamber of Commerce, Director of Business and Education Partnerships, Ross Hamilton, conducted an informal survey of a sample of local businesses for us, asking them about their math expectations for recent high school graduates. They explained that workers should be able to do multiplication, find percentages, calculate sales tax and be able to set up a math equation to be solved. Calculators generally can be used to help them find the correct answer. If they can not find a correct answer, they should be able to recognize that and ask for help. Employers in our area suggested they would be "somewhat" willing to train entry level workers in their specific workplace, but new employees with a high school education really need to know the basics and have a desire to want to know how to find math solutions correctly.

The March 12 issue of Parade in the Kalamazoo Gazette featured an article "What People Earn". They reiterated the statistics showing education is vital to getting a good job. On average, full-time workers with a high school diploma earn $585 per week, while those with a college degree earn $1029 per week.

Suggestions for K-12 Education*

The common suggestions from the post-K-12 schools are summarized into six key areas:

- Understanding math
- Use of calculators
- Testing
- Knowledge of math facts
- Algebra
- About the "new" math

Also included in this section are findings from the ACT / Education Trust Publication "On Course for Success" which summarized consistent practices from schools where a large percent of students achieve academic success in math (35% or more score 22 or above on ACT Math). And finally, the faculty at these universities offers a range of opportunities to work together with public schools to help improve math education.

Understanding Math

Everyone interviewed was passionate about the importance of helping students develop an understanding of math. Elementary math education is critical, because "students who have a firm foundation of the basics are better equipped to understand more advanced math. Students who have a weak foundation find advanced math more frustrating and tend to pass by memorizing rather than learning and thinking." (MSU) Students who do not understand math "view it as a collection of tricks and do not perceive math as a coherent whole" (GVSU). "Perhaps there is a misconception that elementary math is elementary" (GVSU). This point also made by Dr. Glenda Lappan when she presented examples of fourth grade students' math solutions at the PPS Math Curriculum Review Team meeting 2/1/06. "The goal for math education at all levels is to achieve understanding and to get math knowledge to stick." (UM) Some specific ideas include:

- specialized math teachers in elementary school
- encouraging students to Read-Write-Do
- use a mix of individual and group work
- include "real-world" examples
- carefully align the use of math books to the most important topics, teach depth
- don't teach too fast (K-12), teach to achieve understanding

Knowledge of Math Facts and Math vocabulary

Uniformly, colleges want students to know multiplication facts, as well as math skills including applied geometry formulas and algebraic manipulations. One professor said, "It makes me sad to have a student I am tutoring in calculus have to use their calculator to multiply 6 times 8." "Some things just have to be learned by heart to create math fluency." (UM) Try to teach students to "speak like mathematicians" using correct mathematical terminology (ACT/Ed Trust). "Consistency of terminology is important" (Lappan 2/1/06. "Fluency" in math might be compared to fluency in language, whereby basics (words) are memorized and used in diverse application.

Use of Calculators

Clearly, calculators are a useful tool and in many cases, critical. However, faculty believes students have become far too dependent on calculators to the detriment of math understanding and basic knowledge. All schools agree that calculators use should be limited, especially K-6. Many universities, (WMU, MSU, UM) administer calculator-free tests on a regular basis to ensure students develop manipulative skills as well as a clear understanding of the material. "Students should be confident to take basic math exams without calculators" (WMU)

*Suggestions were made by faculty interviewed and do not represent a position of the institution.

Algebra

Faculty consistently opined that Algebra proficiency is the key to more advanced math.

- "Students need a solid foundation and mathematical maturity before taking calculus." (UM)
- "Students need to know Algebra. (WMU)
- "Grades 5-7 should be a preparation for 'real', algebraic math that leads to a solid grade 8 algebra course, focusing on quadratic equations and polynomials." (MSU)
- "It is good to offer calculus in high school, but only to students who have truly 'out-run' the curriculum. (UM)
- Successful schools focus on an "algebra-dominated sequence of courses in high school, with the emphasis in the teaching on manipulating algorithms". (Ed Trust)
- Take the time to really teach, and make certain the students learn and understand, Algebra.

This recommendation is supported by a publication from The Education Trust 2002, Thinking K-16. From 1982 to 1998 the number of high school students taking Algebra II increased from 40% to 62%. The number of high school students taking pre-calculus increased from 6% to 22%. Despite these advances, student placement into remedial math at the college level has steadily increased.

Testing

Testing was mentioned consistently as an important tool to assess student learning. Tests should be given regularly, including short, immediate feedback tests as well as comprehensive chapter and semester tests. Multiple choice tests should be avoided, as well as test questions that are clones of examples or homework. Use timed tests to assess fluency. Use calculator-free tests on a regular basis. Use standardized tests frequently, standard within a school, within a district, across a state, ACT, AP, and IB. The use of standardized tests ensures consistency and can help schools "determine if the curriculum is being learned to the required level." (UM)

About the "new" math

These professors and schools vary on their opinions about traditional math versus "integrated" or new math. Many have a strong history of support to one program or the other. A recent article, "Reaching for Common Ground in K-12 Mathematics Education" (2005 The Mathematics Association of America) finds a basis of agreement for these opposing positions. The findings in this report are consistent with the findings in that report with one notable exception. None of the universities interviewed believed strongly that a majority of high school students should have studied calculus. These contacts emphasized thorough Algebra knowledge, then flexibility around statistics, pre-calculus or calculus depending on the student's long-term career interests.

The Education Trust / ACT publication did find that in their successful schools, "the mathematics taught…can best be described as traditional college preparatory mathematics" using a traditional style (pg37). Perhaps more data evidence is needed to resolve specific debates on this topic.

Partner with the Universities

1) The Universities contacted will provide data to school districts about overall student trends as well as specific information about a district's graduates. This information could provide valuable insight to curriculum effectiveness if integrated back into student history, not only for math but all key subject areas.

2) All four universities, UM, MSU, GVSU and WMU have active research projects underway to help improve education for math educators. Most of these are partnerships between the Schools of Education and the Mathematics Departments. Professional Development opportunities exist for public schools K-12 teachers interested in learning more about their findings

MATH CURRICULUM REVIEW
RESEARCH ON
"AFTER HIGH SCHOOL" MATH EXPECTATIONS
FINAL REPORT

Appendices

KALAMAZOO VALLEY COMMUNITY COLLEGE

Contact: www.kvcc.edu

Denise Lindsley	Assessment Specialist	269-488-4437
Laura Cosby	Director Placement programs	269-488-4440
Lee Marsh	Head of Math Department	269-488-4309

Interviewed: January 25, 2006, February 1, 2006

Math expectations for incoming freshman

KVCC has no expectation for incoming students, as they can accommodate all levels of math knowledge. All incoming students must take a placement test for reading, writing and math as a means to determine which courses a student should take. Credit can be earned by testing out. KVCC does not guarantee the credits awarded through prior learning assessments will transfer to other institutions.

KVCC offers Certificate of Achievement, Certificate and Associates Degrees. These are called "Go To Work" degrees. Few of the certificate programs require any math. They are specific to a trade. Associate degrees have some math requirement depending on the program. Math requirements for KVCC degrees do not exceed Math 116, Intermediate Algebra, roughly equivalent to Algebra II in high school but more advanced.

About half the students enrolled at KVCC are working on a transfer program. Most are taking courses that would enable them to transfer to four-year universities at a into a junior level. The math requirements for these programs depend on the target degree and target university.

Math placement exam

The math placement exam is computer based and multiple choice, one question at a time. The test begins with an Algebra question. Based on whether the answer is correct or not, the next question is posed. Correct answers move the student to more advanced topics, incorrect answers move to more basic topics. There are a total of 9 questions asked. .

Results of placement exam

The results of the exam are used to recommend the appropriate level math class. They believe this process is fairly accurate. Students can request to re-take the exam, but the result does not change very often

Observations regarding trends in student readiness

Over the last five years, most incoming students place in the 9X level classes which are considered remedial. The number of students placing at a remedial level has increased recently. It should be noted that some number of students come to KVCC having been away from school for a while.

YEAR	% in 9X level	% above 9X level
2003	66%	34%
2004	70%	30%
2005	73%	27%

In 2005, 178 (9%) of the newly enrolled students were Portage graduates.

Portage 2005 grads	55%	45%
Portage pre-2005 grads	84%	16%

Many students come in thinking they are ready or beyond Math 116, College Algebra. They are surprised to find they may have to take two or three courses before they are actually ready for that level course.

Ideas for K-12 Math education

In general, it is believed that the new, proposed State of Michigan high school graduation requirement for math will be good for all students who may want to attend KVCC. The students will find themselves better prepared for the recommended math courses, even those less rigorous, job-targeted courses

Instructors at KVCC believe they are seeing students who are even more prepared than in the past. This may be because more college-bound students are choosing to start at KVCC, perhaps to save money. They are also seeing more high school students who are dual-enrolled.

Placing students into appropriate courses is a high priority at KVCC. They believe the placement exam is pretty good for this. It appears students are more likely to be placed appropriately if they have practiced their math skills on a continuous basis so they are nor “rusty”, an endorsement for encouraging seniors in high school to take a math course.

Much effort is currently being put into continuing the focus on proper placement beyond the first course. Every class of each course has a final which includes 10 consistent questions. These 10 questions represent the 10 most critical topics taught in that course. These questions are graded more heavily as a determinate of the student’s mastery of the relevant material and readiness for the next class.

The next class starts with these 10 questions as pre-requisite knowledge. The instructors spend a week in review then administer these questions. Students who perform poorly are strongly counseled to reconsider their placement.

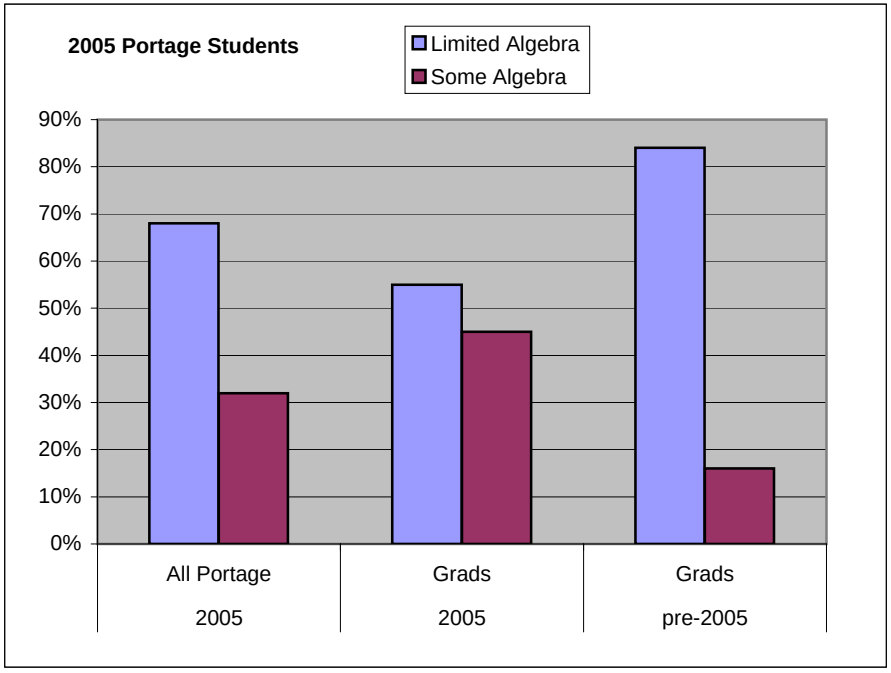
KVCC uses Instructor Evaluations which are completed by students 12 weeks into the course. A correlation has been noted that some students who are unhappy with their instructor in fact had weak course readiness. KVCC works hard to ensure that they have the best instructors they can hire, but they are working hard to balance student responsibility with teacher performance.

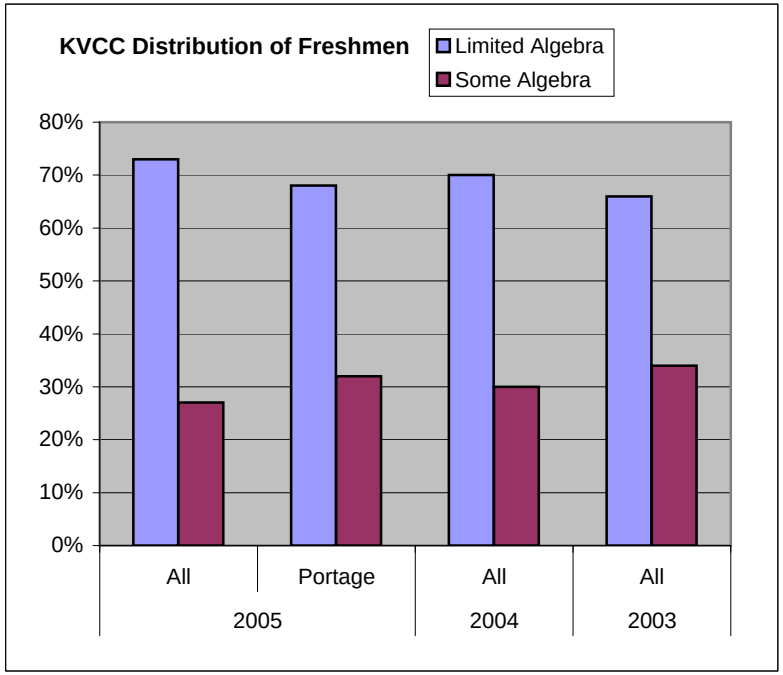
KVCC Distribution of Freshmen in Math Courses over the last three years

Level	2005 All	Portage	2004 All	2003 All
Limited Algebra	73%	68%	70%	66%
Some Algebra	27%	32%	30%	34%

2005 Portage Students

	2005 All Portage	2005 Grads	pre-2005 Grads
Limited Algebra	68%	55%	84%
Some Algebra	32%	45%	16%
Total #	178	103	75





WESTERN MICHIGAN UNIVERSITY

Contact:
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Undergraduate Coordinator
Department of Mathematics

Interviewed: Thursday, December 15, 2005

Math expectations for incoming freshman

Every incoming freshman must take at least one math course having Algebra I as a prerequisite, so the expectation is that students will have a good base of algebra skills. Students could move on to Algebra or branch to Excursions in Math or "Math in Society" courses, or Elementary Education Math, OR Math for Business Students. WMU recommends students take at least four years of math in high school to be well-prepared for college. The emphasis should be placed on learning well and thoroughly, not rushing in to higher level courses.

Math placement exam

WMU has had a math entrance exam as part of freshman orientation. Recently, orientation has been cut down to one day, so there is not adequate time for the exam. Temporarily, ACT scores are used to place students into appropriate courses. Since this is a new process, there is limited data to indicate how well the ACT score placement is working. There continue to be failures and drop-outs in the Calculus classes although this could be caused by lack of attendance as well as math readiness.

The WMU Math Department is currently moving toward an on-line placement exam for students, possibly in a multiple choice format.

Results of placement exam

This year, students were placed in courses based on ACT scores as follows:

Math ACT Score	Course
27	Calculus I
24	PreCalculus (includes trigonometry)
19	Algebra II
16	Algebra I
Below	PreAlgebra

Students who achieve 3 or higher on an AP Calculus exam are placed into Calculus II and given credit for Calculus I.

The Pre-Algebra course is offered, but no credit is given. Algebra I and II can be taken for credit, but are considered remedial.

Observations regarding trends in student readiness

Students seem to be lacking Algebra skills, which inhibits their learning of calculus. Rather than rushing into Calculus in high school, it would be better to make certain students know their Algebra. If students are ready, a legitimate AP Calculus class is good and should include the AP exam. The AP exam has been a good indicator of calculus readiness, but it seems to be weaker (specifically on algebra) than in the past.

Students have become too dependent on calculators. Typically, college calculus classes allow calculators for about half of the exams and require the other half be calculator free.

Ideas for K-12 Math education

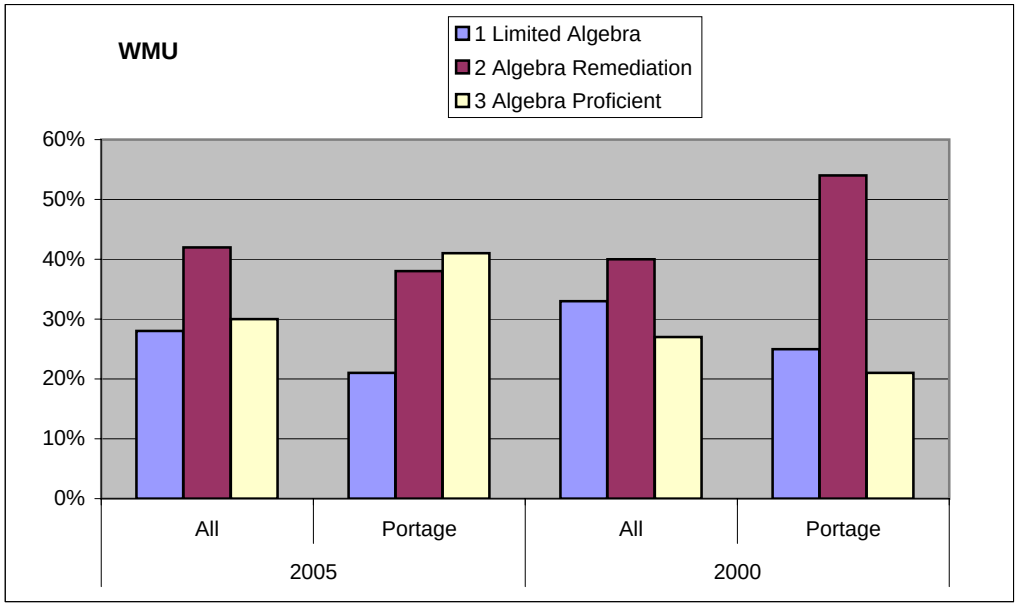
It is important for students to know their basics before they come to college. They should know their multiplication facts through 12. They should be confident to take basic math exams without calculators and they should know Algebra. Geometry and trigonometry are important also if they plan to major in science or engineering. Some other ideas to consider include:

- test students regularly, to ensure understanding
- stay away from multiple choice tests, where possible
- use word problems
- minimize the use of calculators, especially K-6
- limit the ability to re-take exams, learning accountability is important
- exposure to statistics is good

Reviewed & approved 1/17/2006

Distribution of New WMU Freshmen in Math Courses Taken in First Fall Semester
Fall 2005 vs Fall 2000

Level		2005 All	2005 Portage	2000 All	2000 Portage
1	Limited Algebra	28%	21%	33%	25%
2	Algebra Remediation	42%	38%	40%	54%
3	Algebra Proficient	30%	41%	27%	21%
	Total #	2246	63	2736	48



GRAND VALLEY STATE UNIVERSITY

Contact:
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Math Department Chair
GVSU Website – www.gvsu.edu
Interviewed: February 3, 2006

Math expectations for incoming freshman

All students are required to meet a math requirement as part of their GVSU degree. The minimum requirement is Math 110, an Intermediate Algebra course with an emphasis on applications. To be prepared for college math, students should have at least 3 years of college prep math courses, although four years is strongly recommended.

Math placement exam

To ensure students begin their study of mathematics as the appropriate level, all entering students are advised as to which math course in which they should enroll. Placement is initially recommended based on the Math ACT score in combination with high school math taken

If students disagree with their recommended placement into Math 097 – Elementary Algebra or Math 110 , or wish to waive the Math 110 course, they may take a placement test. This test may be taken only once. A sample of the test is available online. The test has 50 multiple choice questions and takes 50 minutes. Students can use calculator

Students who place beyond Math 110 and plan to take additional math courses can take a second placement exam which is a calculus-readiness exam. The results of this exam allow the student and the University to assess the appropriate level of calculus-related course placement.

Results of placement exam

The ACT score & high school courses map to course placement as follows:

Math ACT Score	High school courses	Recommended GVSU Course
Under 18	3 math courses	Math 097
19-26	3 math courses	Math 110
27 & up	3 math courses	Waive Math 110
Under 17	4 math courses	Math 097
18-25	4 math courses	Math 110
26 & up	4 math courses	Waive Math 110

The Math placement test results map as follows:

Test score	Recommended GVSU course
16-22	Math 097 - remedial
23-33	Math 110 - beginning
34+	Waive Math 110

No credit is issued when Math 110 is waived, but the graduation requirement is met. The calculus-readiness exam results typically place students into one of three courses:
Math 122 – College Algebra, Math 123 – Trigonometry or Math 201 - Calculus 1.

Observations regarding trends in student readiness

GVSU has been increasing the education profile of incoming freshmen over the last ten years. As such, they have found the number of students requiring remedial math is decreasing. Fewer sections of the remedial Math 097 are required and Math 096, a more remedial level course, is no longer offered.

Ideas for K-12 Math education

Students need to understand mathematical concepts and have manipulative skills. This is a difficult balance in the K-12 curriculum, but is very important. Students who do not understand concepts view math as a ”collection of tricks” and have do not perceive math as a “coherent whole”. Of course, students need strong manipulative skills to be able to put math concepts into practice and application.

The teaching needs to begin at the elementary level. Students need to be able to answer “Why can you do what you are doing?” Perhaps there is a misconception that elementary math is elementary, when, in fact, it is full of deep concepts, just not as formal in presentation and application. Elementary math teachers need to be aware of this deep and broad concept to really help students learn. Many elementary students will ask very deep questions about math without even being aware of how it is full of deep concepts, just not as formal in presentation and application. Elementary math teachers need to be aware of this deep and broad concept to really help students learn. Many elementary students will ask very deep questions about math without even being aware of its significance.

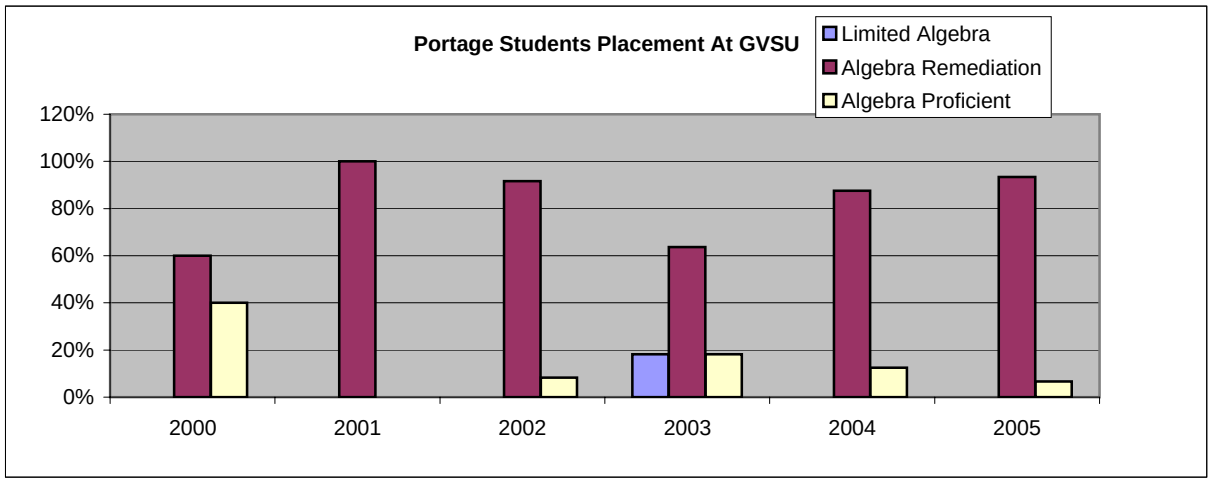
GVSU currently has 400 math majors with about two thirds prospective teachers. “We teach math education at GVSU with the philosophy to teach our students as we want them to teach. Many elementary education students (prospective teachers) admit they are not the fondest of math. (Perhaps they would put it more strongly?) Thus, we are honor bound to change their opinion of math…” (Source www.gvsu.edu/math/mathed.html)

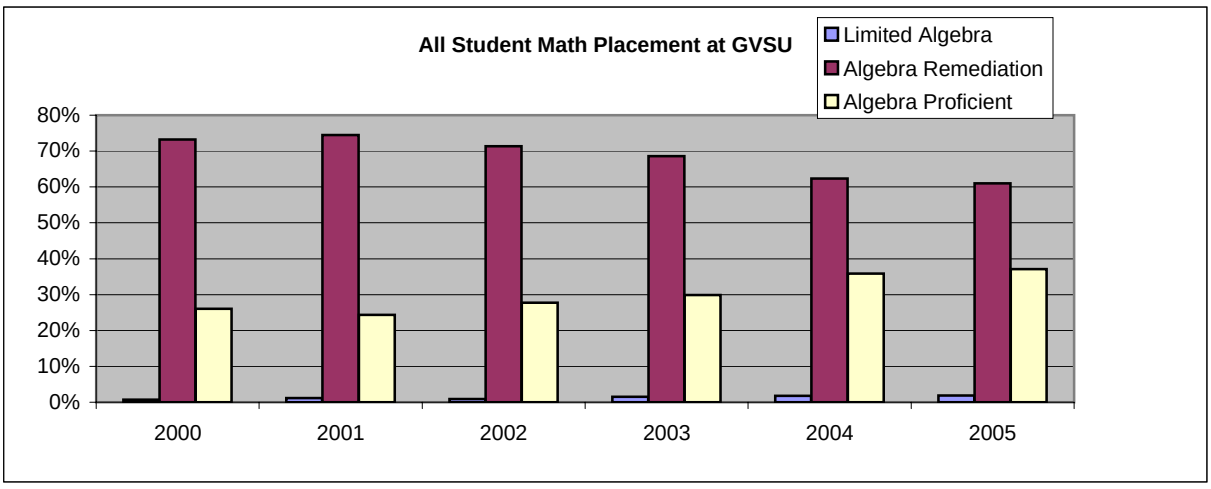
Another focus of the Math Department at GVSU is called “Enhancing the Core”. This is a coordinated effort of mathematicians, math educators and statisticians to improve the math education of ALL majors. A PowerPoint presentation describing this effort is available at www.gvsu.edu/math/ETC/.

Grand Valley State University

Math placement: Degree-seeking freshmen

Portage	2000	2001	2002	2003	2004	2005
Limited Algebra	0%	0%	0%	18%	0%	0%
Algebra Remediation	60%	100%	92%	64%	88%	93%
Algebra Proficient	40%	0%	8%	18%	13%	7%
Total #	10	7	12	11	8	15
All Students	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Limited Algebra	1%	1%	1%	2%	2%	2%
Algebra Remediation	73%	74%	71%	69%	62%	61%
Algebra Proficient	26%	24%	28%	30%	36%	37%
Total #	2852	3003	2888	3285	3339	3416





MICHIGAN STATE UNIVERSITY

Contact:

Preliminary contact www.mth.msu.edu
Thomas Parker (517) 353-8493 parker@math.msu.edu
Professor of Mathematics,
currently teaching Math for Elementary Teachers and Geometric Topology

Interviewed: Wednesday, January 17, 2006

Math expectations for entering freshman

The minimum recommendation is for to students take at least three years of math in high school, two years of algebra and one year of geometry.

While the entrance requirement is for three year of math, students who have taken ONLY three years of high school math place themselves at a severe disadvantage, as most students who enter MSU with the minimum find they are placed into remedial math and must take an additional math course at MSU to satisfy the graduation requirement. Students are STRONGLY encouraged to take at least four years of high school math including a calculus prep course.

The following is recommended for students to place beyond remedial math:

- 4 years of college prep math in grades 9-12
- An average of B or better in high school math courses
- An ACT score of at least 19 in math

Mastery of the material is essential. It is important that students learn math with an emphasis on understanding and applications AS WELL AS routine manipulative skills.

Math placement exams

All undergraduates new to MSU are required to take a math placement exam. The exam is available in a computer format and is available to high schools via the math Department home page at http://www.math.msu.edu.

The placement exam consists of 28 questions and students are not allowed to use calculators during the exam

Results of exams and consequences

Score	Placement
0-7	Math 1825 – remedial math
8-9	If math ACT is higher than 12, then Math 103 College Algebra, else 1825
10 or higher	Math 103 or Math 110 Finite Math and College Algebra
12 or higher	Math 116 College Algebra and Trig
15 or higher	Math 106 The Significance of Math Math 124 Survey of Calc I Math 201 Mathematical Investigations I Stats 200 or 201 Statistical Methods
19 or higher	Math 132 Calculus I

All courses listed, if successfully completed, meet the math requirement for graduation from MSU, except 1825 and 103. Students who place into these two courses will be required to take additional math classes.

Students who take AP calculus in high school can receive college credit if they score high enough on the AP exam. Calc AB sore of 4 and 5 and Calc BC score of 3,4 or 5 allow credit for math 132. (More details are specified. This is a summary.)

Observations regarding student readiness

Each fall, placements are approximately as follows:

- 30 % place into Math 1825 remedial
- 30% Math 103 not remedial, but does not meet graduation req.
- 20% Math 116
- 20% Math 132

Extensive surveys are taken on incoming students relative to previous math experience and current placement. The following have been established by various studies:

- More than half the students entering MSU who have had less than four years of math in high school place into remedial math.
- About one in five students who place into remedial math fail the course.
- More than half of the students who place into remedial math had four years of math in high school.
- More than half of the students who place into remedial math had a B average or better in high school math classes.

Enrollment in high school math courses, per se, does not provide sufficient background for students who will attend MSU. Mastery of the material is essential. It is important that students learn math with an emphasis on understanding and applications AS WELL AS routine manipulative skills.

Ideas for K-12 Math education

Good math education is facilitated through the selection and use of substantive math books K-12. The debate about Integrated math versus Traditional math is less important. Both concepts can work. Unfortunately, the "integrated" texts currently available are all weak.

One of the characteristics of bad books is the over-emphasis on group work and "real-life problems" that require inordinate commitments of time. As a result, time is not available to cover all the important topics. For example, the High School Core Plus program is missing important skills in algebra, geometry, trigonometry and precalculus. The elementary programs written in the 1990s have eliminated many important topics and, while they claim to be developing "conceptual understanding", are not. Some districts have tried to fill the gaps by supplementing with focused drills and assignments. The problem with this strategy is that the link between the focused learning and the concepts and applications is missing. Students do not understand the relationship and thus do not develop a good understanding.

Other textbooks are too big and unfocused; they have lots of color pictures, but they lack of a coherent strategy and it is often difficult to find the mathematics amid the clutter. Many topics are covered, but it is unclear which are important and which are "supplemental". Teachers have difficulty determining the appropriate use of these books especially if there is too much material to cover in one academic year.

The biggest potential positive impact for improving math learning can be made at the elementary level. Students who have a firm foundation of the basics are better equipped to understand more advanced math. Students who have a weak foundation find more advanced math frustrating and tend to pass by memorizing rather than learning and thinking. Schools might consider having specialized math teachers at the elementary level, if not k-5 then perhaps 3-4-5. Specialized teachers can develop their programs thoroughly and follow students and the curriculum over time to evaluate effectiveness. A very good math book series is Singapore "Primary Mathematics" series for grades K-6. The books are used in Singapore, hence the name, the country which has scored the highest for math in the TIMMS studies. The books are published in English and come with a textbook and workbook (available at www.singaporemath.com).

Letter from Professor Thomas Parker
Re Math Education

Mariam Stricklen, an Okemos parent, wrote an opinion column that appeared in Lansing State Journal on June 18, 1999. The column praised the Connnected Mathematics Projects, in large measure because it was rated very well in a recent report by the American Acadamy for the Advancement of Science (AAAS). Below is a response by Prof. Thomas Parker in the form of a letter to Ms Stricklen.

I would like to make a few comments--- helpful ones I hope--- on your LSJ article.

I am a MSU Math professor. While I am a research mathematician, I have been teaching courses in Math Education, and have been closely following current developments in Math education. Evaluating Math programs is a tricky business in the current environment. There are major battles going on, and reports from even trusted sources are usually tinged with the politics of these battles.

The AAAS report is a case in point. It was not written by scientists. Rather, the AAAS has lent its imprimatur, under the name `Project 2061' , to a group of EDUCATORS who are not trained in mathematics or science. These educators have a specific political agenda. They would like to see all education done in group settings with the `discovery method' and with no instruction from the teacher. They would like to see mathematics classes with long writing assignments, no right and wrong answers, no practice problems, complete reliance on calculators, and a minimization of algebra.

Accordingly, they designed a set of criteria focusing not on WHAT and HOW mathematics is covered by the program, but rather on the extent to which it conforms to the above agenda. Take a close look at the Project 2061 website: "http://project2061.aaas.org/newsinfo/press/attach_a.pdf" Your chart is Attachment A. Note that it is titled `quality of instruction'. It is a ranking of the INSTRUCTIONAL PRACTICES used by the math program, not a ranking of the overall quality of the program. Attachment B spells out the criteria. The `Benchmarks' (made up by the 2061 people) describe a dumbed-down middle school program. In other programs and in other countries most of these topics are covered in grades 4-5. Some ("shapes can match exactly or have the same shape in different sizes") are kindergarten level, and not even correct English! For each of these `benchmarks' the 2061 group applied the `criteria of quality of instructional guidance' listed at the bottom of Attachment B. Here you see the political agenda I described above. Many of these phrases are educational jargon that require experience to decode. For example, the three listed under Category VI all mean ``no tests, quizzes or worksheets" and the two in Category III mean ``group work with manipulatives". The last one, `supporting all students' means `dumbed down'.

None of these criteria assess what specific mathematics is covered. Thus the Connected Mathematics Project (CMP) can be the highest rated, even though the topics it covers in grade 8 are covered in grade 7 in competing programs, and covered in grade 6 in Japan, Korean, China, Singapore and Russia.

All that one should conclude from the Project 2061 report is that their top-rated programs are politically correct. I have looked over the CMP program carefully. It definitely is politically correct.

What criteria should be used? A good math program has several stages. Grades K-4 should throughly cover the basics: addition, subtraction, multiplication, division, fractions, and a little geometry. Grades 5--7 should be preparation for the real math that starts with a solid grade 8 algebra course focusing on quadratic equations and polynomials, and a grade 9 course in Euclidean geometry, with proofs. (That is the plan followed by most countries, and the one recommended by the U.S. Department of Education). Virtually all students find these two courses very hard; many find them TOO hard and drop out of math at that point. But these courses are not intrinsically difficult. In other countries ALL students take them as a matter of routine and, as the TIMSS study shows, master the material. The problem lies in the US grade 5--7 programs. There our children spend their time going over more arithmetic, instead of taking the first steps toward real algebra and geometry with proofs.

This last sentence exactly describes the problem with CMP and similar programs. The Project 2061 report does not reveal this fundamental deficiency because its criteria do not include real algebra and geometry with proofs.

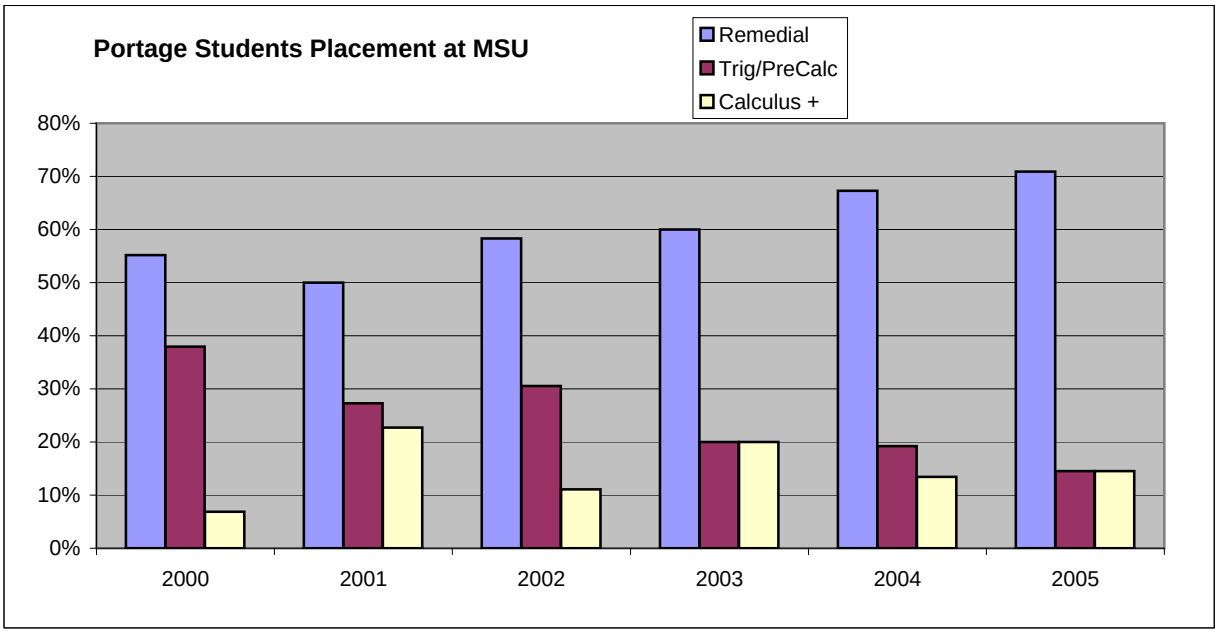
For different ratings, ones based on the actual mathematics covered and taught, see the website "http://www.mathematicallycorrect.com/" Click on the 5th line called ``Mathematics Program Reviews for Grades 2, 5, and 7 ". ('Mathematically Correct' is an organization of parents and scientists who are working to restore serious mathematics to schools. A study of their website is essential for understanding the battle lines in the current debate over mathematics education).

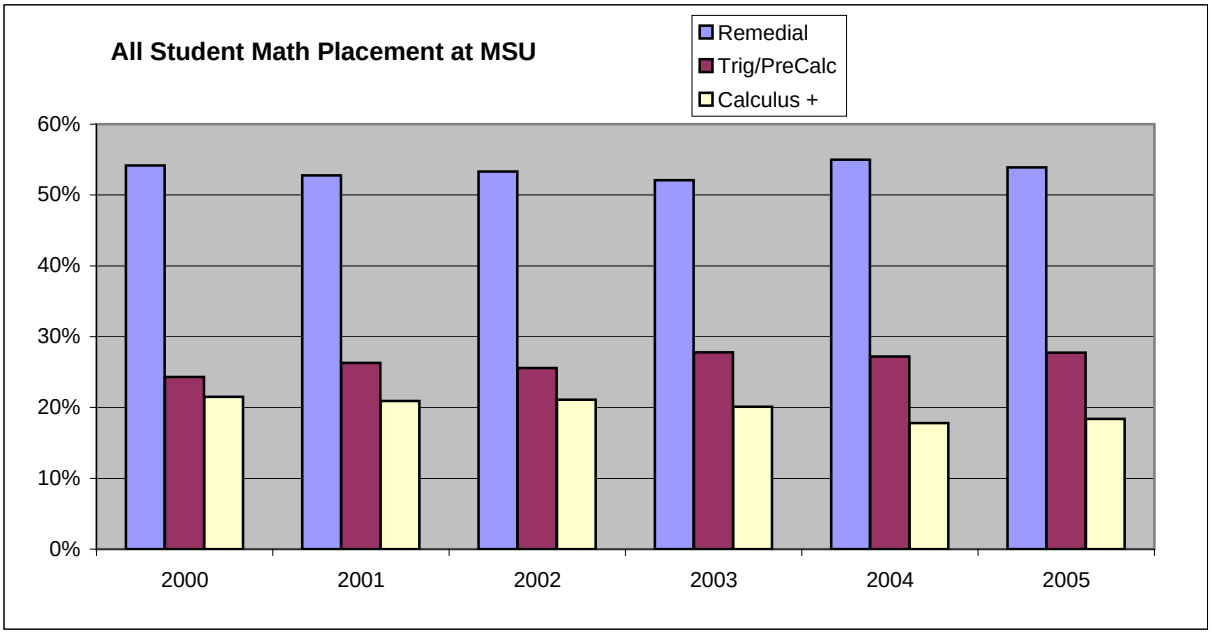
Sincerely,
Tom Parker

MICHIGAN STATE UNIVERSITY
OFFICE OF THE REGISTRAR
MATH COURSES TAKEN THE 1ST TERM IN ATTENDANCE
FOR FIRST-TIME FRESHMEN

Portage	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Remedial	55%	50%	58%	60%	67%	71%
Trig/PreCalc	38%	27%	31%	20%	19%	15%
Calculus +	7%	23%	11%	20%	13%	15%
TOTAL #	29	22	36	35	52	55

All Students	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Remedial	54%	53%	53%	52%	55%	54%
Trig/PreCalc	24%	26%	26%	28%	27%	28%
Calculus +	22%	21%	21%	20%	18%	18%
TOTAL #	5431	5474	5701	5502	5932	5793





UNIVERSITY OF MICHIGAN

Contact:

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Senior Lecturer in Mathematics
Director of Introductory Mathematics Program
Director of Professional Development for Faculty and Graduate Instructors
Member of the Harvard Consortium Math Textbook-Writing Group

Interviewed: Friday, November 4, 2005

Math expectations for incoming freshman

Students who expect to take math at UM should have taken 4 years of in-depth high school math. Most UM freshmen are either ready for calculus or have already taken it when they arrive. The UM courses will focus on understanding ideas and applying them in real-life contexts. In order to concentrate on concepts, certain algebra skills must be automatic.

They should have strong math fluency, meaning strong manipulation and calculation skills as well as thorough knowledge of math vocabulary. Strong fluency also implies the ability to utilize math skills quickly without the aid of a calculator. Specific skills and knowledge recommendations include:

- Exponents
- Algebraic multiplication
- Factoring
- Fractions
- Changing the form of expressions
- Logarithms
- Solving equations and inequalities
- Setting up functions from descriptions and using function notation
- Combining evaluation, graphing and solving
- Composition of functions and substituting
- Recognizing common types of functions
- Common graphs for memorizing
- Formulas and functions for memorizing

A reference workbook was provided with specific examples of these expectations. There is also an online tutorial at http://prep.math.lsa.umich.edu/

Math placement exam

UM has a placement exam which must be taken by all incoming freshmen. The score on this exam is combined with the student's high school GPA and ACT or SAT scores to generate a recommended beginning course. It is to assist counselors in determining which first math class students should take.

Basically, the exam answers the question, "Is the student ready for calculus, yes or no?". The test is not a comprehensive assessment of the student's math knowledge and in no way reflects the breadth of what the University expects in a full high school curriculum. For example, it contains no questions about geometry or statistics.

The placement exam can be taken on-line. No calculators are permitted. The test is timed. Practice versions of the test are available.

Results of placement exam

Students who are ready for calculus will be placed in the course reflective of their readiness. Only one pre-calculus course, Math 105, is available at UM. The course covers data, functions and graphs. Incoming freshman have traditionally placed about ¼ in Math 105, ½ in Calculus I and ¼ in Calculus II.

Math 105 is not considered remedial since students do get 4 credits for the class. The only exception is engineers, who do not receive credit for this class. The only way to get credit for a math class taken in high school is to score a 4 or 5 on one of the AP Calculus tests.

Observations regarding student readiness

Students are not as "fluent" as they should be, meaning basic algebra calculations take them too much time and are often wrong. Over the past years there seems to be an increasing reliance on calculators to do ordinary algebra.

Core-Plus is a good curriculum (for all students, not just for students weak in math), and the upcoming revisions strengthen it. Some of the algebra previously covered in the 4th year, now comes earlier. Teachers need to do the supplemental drills to ensure algebra fluency.

Ideas for K-12 Math education

The goal for math education at all levels, K-16, is to achieve understanding and to get math knowledge to "stick". All students should be expected to be math fluent at each level, meaning solid understanding backed up by strong manipulation and calculation skills as well as thorough knowledge of math vocabulary. Strong fluency also implies the ability to demonstrate math skills quickly without the aid of a calculator. We, the teaching community, know how to teach math, READ – WRITE – TALK- DO.

Suggestions to prepare for math classes at UM:

- Use calculators where appropriate (exploration, messy calculations, checking), not as a crutch. It is good to teach how to use them, but they should not replace pencil and paper. Some things just must be learned by heart to create math fluency.
- Students should be encouraged to write about math as well as perform calculations. Students should be encouraged to work in groups to initiate talk/discussion about math.
- UM math grades
    - Use timed tests help to assess fluency.
    - Have some tests, or portions of tests, that are calculator-free.
    - Develop questions that test concepts but are NOT clones of the examples and problems in the book.

- Encourage students to justify their reasoning on tests.
- Comprehensive exams are important, covering large chunks of information, not just a section or chapter in a book. Comprehensive exams assess the depth of understanding of the material.
- Don't teach the curriculum too fast. The focus should be on achieving a real level of understanding and fluency. Students need a solid foundation and mathematical maturity before taking calculus. It is good to offer AP Calc BC level, but only for the students who have really "out-run" the curriculum.
- All college-bound students should be strongly encouraged to take four years of "heavy-duty" math. As seniors, the choice between calculus or statistics should be based on career direction. Both courses are fine.
- If a school offers AP courses (and perhaps IB), the exam should be required. This is how schools can determine if the curriculum is being learned to the required level.

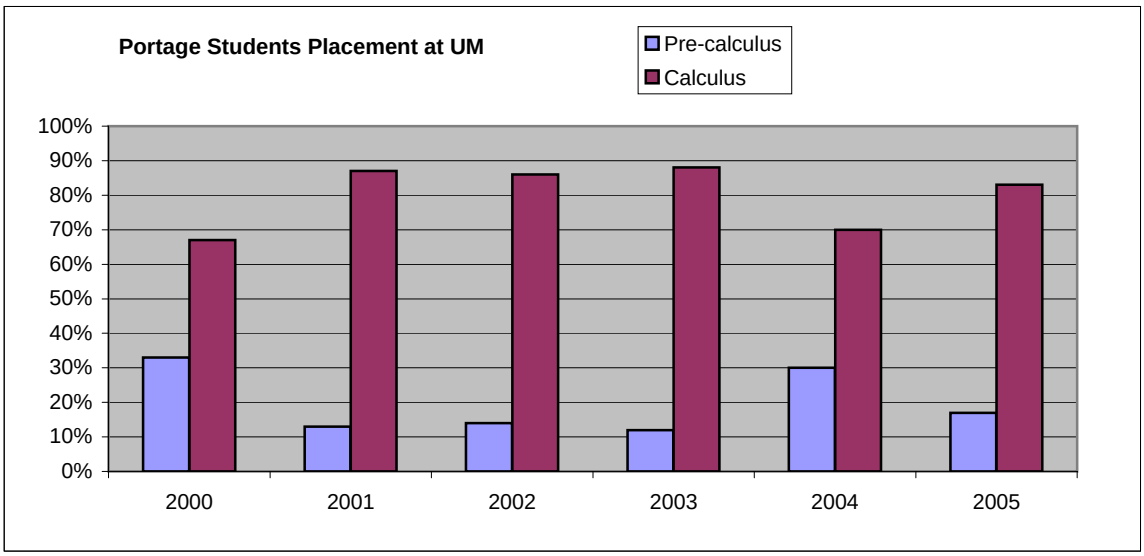
UM Distribution of Freshmen in Math Courses

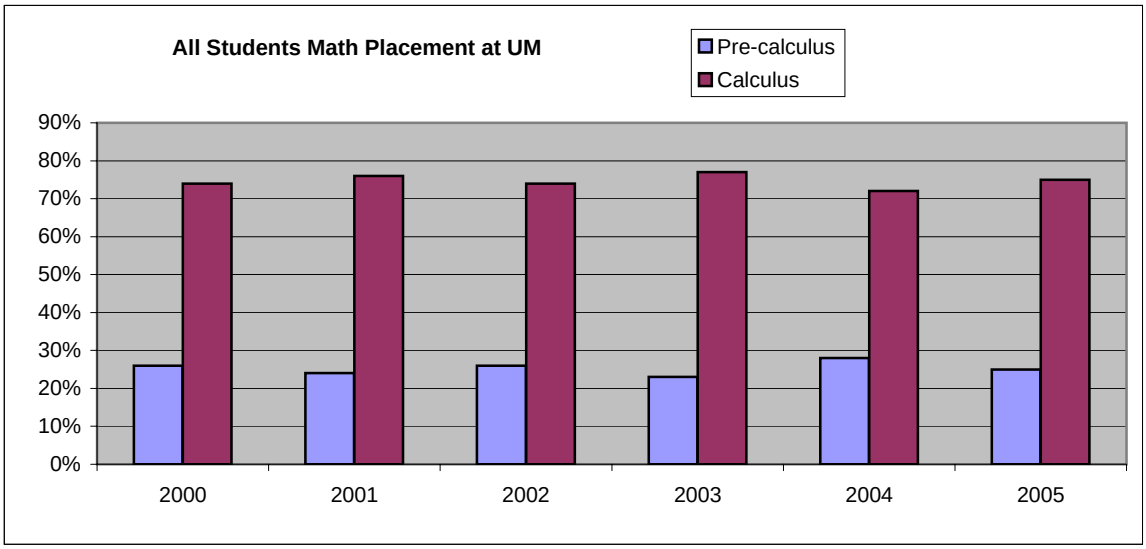
Portage

	2000	2001	2002	2003	2004	2005
Pre-calculus	33%	13%	14%	12%	30%	17%
Calculus	67%	87%	86%	88%	70%	83%
Total #	18	30	21	17	27	35

All Students

	2000	2001	2002	2003	2004	2005
Pre-calculus	26%	24%	26%	23%	28%	25%
Calculus	74%	76%	74%	77%	72%	75%
Total #	2570	2457	2162	2309	2765	2640





Column titles changed from "remedial" to "pre-calculus" per P. Shure 5/15/2006

UNIVERSAL TECHNICAL INSTITUTE

Contact: **www.uticorp.com/go/schools/uti/industrycacts/**

Michelle Admissions consultant 800-859-7249

Interviewed: February 7, 2006

Math expectations for incoming freshman

Students are encouraged to have a high school degree or GED. Students who are 21 years old or more can be considered without a degree. At minimum, students need to have 9th grade math proficiency, Algebra I, and proficiency with a scientific calculator.

The specific recommendations are provided in a link from UTI's website:

"Automotive technology is rapidly increasing in sophistication and most training authorities strongly recommend that persons …complete a formal training program in high school or community college…"

"Courses in automotive repair, electronics, physics, chemistry, English, computers and mathematics provide a good educational background for a career as a service technician."

Math placement exam

None

Observations regarding trends in student readiness

Students seem to begin having difficulty in courses in electricity which requires math knowledge.

From: Hamilton, Ross [mailto:rhamilton@kazoochamber.com]
Sent: Saturday, March 11, 2006 7:42 AM
To: Melanie Kurdys
Subject: RE: K - 12 MATH PROGRAM

Hello Melanie, You're welcome, I'm pleased we could help you.

Good luck with your worthwhile project!
Ross Hamilton

From: Melanie Kurdys [mailto:gingerbitus@mindspring.com]
Sent: Fri 3/10/2006 8:31 PM
To: Hamilton, Ross
Subject: RE: K - 12 MATH PROGRAM

Thank you very much for taking the time to survey your members. I will incorporate this information into my findings.
Melanie

From: Hamilton, Ross [mailto:rhamilton@kazoochamber.com]
Sent: Friday, March 10, 2006 10:48 AM
To: gingerbitus@mindspring.com
Subject: K - 12 MATH PROGRAM

Good Morning Melanie, I have talked with several business folks re the above, per our conversation earlier this week.
The primary issue they shared was -- entry level (HS diploma) workers fully understand, and are capable to use a
calculator to find the answer regarding multiplications, percentages, calculating sales tax, and the basics in being able
to properly set-up a math equation to be solved -- if they can not secure the correct answer -- be able to properly
communicate the problem to a co-worker, who can help them secure the correct answer.

Some indicated they are "somewhat" willing to train the worker in their specific workplace but -- the entry level worker
really does need to know the basics, and have the desire to want to know how to do it correct.

Hope this helps --
Ross Hamilton

Ross W. Hamilton, Director
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Kalamazoo Regional Chamber of Commerce
269/381.7882
RHamilton@kazoochamber.com

SUMMARY OF ACT / THE EDUCATION TRUST
"On Course For Success"
A close look at high school courses that prepare students for college and work
Submitted by Melanie Kurdys
February 2006

Goal:
To raise the achievement level for all students, closing the gap between majority & minority, high & low income, urban, suburban and rural.

Recommendations:

1) All students should be provided with a rigorous college-oriented curriculum
2) All students should have the benefit of highly qualified teachers.
3) All students should be provided help outside the classroom when needed.
4) The content of current core prep courses should be reevaluated to ensure rigor.

Findings:

1) Nearly 45% of students who declare an intention to go to college have not taken the college-prep courses needed to prepare them.
2) Students who take two or more remedial courses are unlikely to graduate college.
3) Average Math score by high school Math Course sequence

Less than 3 years math	17.2
Algebra I, II, Geometry	17.7
Plus Trig	20.3
Plus another math	22.1

Characteristics of successful Math Teaching:

1) The most successful schools in the survey teach traditional math in a traditional style.
2) Four out of five teachers make connections using real world examples to help understanding.
3) Encourage students to "speak like mathematicians" using correct math terminology.
4) Most schools offer support systems for students who need additional help.
5) Excellent problems teach content while teaching how to solve problems, make conjectures, prove theorems and think mathematically.
6) Students must practice algebra, discuss it, share it with fellow students and write about algebra in order to best learn and internalize it.
7) Use testing and assessments to measure learning.

A more thorough explanation of course design is included in the book.

COLLEGE READINESS

ISSUES IN COLLEGE READINESS

What Are ACT's College Readiness Benchmarks?

ACT's College Readiness Benchmarks are the minimum ACT test scores required for students to have a high probability of success in credit-bearing college courses—English Composition, social sciences courses, Algebra, or Biology. In addition to the Benchmarks for the ACT, there are corresponding EXPLORE® and PLAN® Benchmarks for use by students who take these programs to gauge their progress in becoming college ready in the eighth and tenth grades, respectively. And for students taking COMPASS®, a computer-adaptive course placement assessment used by colleges, we have identified the College Readiness Benchmarks on the COMPASS scale corresponding to success in credit-bearing community college courses.

ACT's College Readiness Benchmarks

College Course or Course Area	Test	EXPLORE Score	PLAN Score	ACT Score	COMPASS Score
English Composition	English	13	15	18	69
Social Sciences	Reading	15	17	21	88
Algebra	Mathematics	17	19	22	65
Biology	Science*	20	21	24	n/a*

Why these courses?

English Composition, Algebra, and Biology are the first credit-bearing courses most commonly taken by first-year college students. Course placement data also show that reading achievement is most closely aligned with success in credit-bearing social sciences courses in college.

What do we mean by "a high probability of success"?

Students who meet a Benchmark on the ACT or COMPASS have approximately a 50 percent chance of earning a B or better and approximately a 75 percent chance of earning a C or better in the corresponding college course or courses. Students who meet a Benchmark on EXPLORE or PLAN are likely to have approximately this same chance of earning such a grade in the corresponding college course(s) by the time they graduate high school.

ACT®

* COMPASS does not contain a science test.

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What data were used to establish the Benchmarks for the ACT?

ACT's College Readiness Benchmarks are empirically derived based on the actual performance of students in college. As part of its Course Placement Service, ACT provides research services to colleges to help them place students in entry-level courses as accurately as possible. In providing these research services, ACT has an extensive database consisting of course grade and test score data from a large number of first-year students and across a wide range of postsecondary institutions. These data provide an overall measure of what it takes to be successful in selected first-year college courses. Data from 98 institutions and over 90,000 students were used to establish the Benchmarks.

For each course, all colleges that supplied data for that course were included. If a college sent data from more than a single year, only data from the most recent year were included. The numbers and types of college varied by course.

Because the sample of colleges in this study is a "convenience" sample (that is, based on data from colleges that chose to participate in ACT's Course Placement Service), there is no guarantee that it is representative of all colleges in the U.S. Therefore, we weighted the sample so that it would be representative of the variety of schools in terms of their selectivity.

How do the Benchmarks for the ACT differ from minimum college course placement scores?

As noted above, the Benchmarks represent a summary across many colleges and many students. The standards for each individual college may vary depending on the material covered in the course and the grading practices within that course. The Benchmarks represent a criterion for success for a *typical* student at a *typical* college. As such, they give students, parents, and counselors useful guidelines to whether a student has mastered the necessary skills to have a reasonable chance of success in college.

ACT will work with any particular postsecondary institution or group of institutions within a state to conduct its own validation studies to establish local benchmarks that, in taking specific institutional and student characteristics into account, can be used as college placement scores.

How were the Benchmarks determined for EXPLORE and PLAN?

The College Readiness Benchmarks for EXPLORE and PLAN were developed using about 150,000 records of students who had taken EXPLORE, PLAN, and the ACT. First, we estimated the probabilities at each EXPLORE and PLAN test score point associated with meeting the appropriate Benchmark for the ACT. We then identified the EXPLORE and PLAN test scores in English, Reading, Mathematics, and Science that corresponded most closely to a 50 percent probability of success at meeting each of the four Benchmarks established for the ACT.

How were the Benchmarks determined for COMPASS?

The College Readiness Benchmarks for COMPASS were developed using the same procedures followed in determining the Benchmarks for the ACT, but with COMPASS data substituted for ACT data.

As with the Benchmarks for the ACT, COMPASS Benchmarks might not serve as the appropriate course placement score at all colleges. Rather, the COMPASS Benchmarks represent a criterion for success for a *typical* student at a *typical* college. ACT will work with any particular postsecondary institution or group of institutions within a state to conduct its own validation studies to establish local benchmarks that, in taking specific institutional and student characteristics into account, can be used as college placement scores.

How can institutions benefit from using the Benchmarks?

Colleges can use the Benchmarks for the ACT as one among several criteria for admission or as a foundation for determining course placement scores. States can use the Benchmarks as a tool for establishing minimum standards for high school graduation in statewide assessment contexts that are aimed at preparing high school graduates for postsecondary education.

Junior high and high schools can use the Benchmarks for EXPLORE and PLAN as a means of evaluating students' early progress toward college readiness so that timely interventions can be made when necessary, or as an educational counseling or career planning tool.

Colleges (especially two-year institutions) can use the Benchmarks for COMPASS to help in efficiently assigning walk-in students to the proper courses and to diagnose student remediation needs.

In all the above cases, the Benchmarks offer users a concise, reliable method of articulating postsecondary expectations to middle and high schools so that timely interventions can be made.

ABOUT THE AUTHOR
Melanie A. Kurdys

Melanie Kurdys is serving as a volunteer analyst for the Portage Public Schools review of the K-12 Math Curriculum. She is on assignment to gather information describing "What students need to know about math when they graduate from high school" with a specific focus on Portage Graduates. She previously served as a parent representative to the Curriculum Instruction Committee for two years.

Melanie is President of the Portage Northern Parent Group serving since 2004, retiring June 2006.

Melanie graduated from the University of Michigan with a BS in Mathematics. She worked as a systems analyst and project manager for IBM and AT&T. She was a Systems Consultant with Arthur Young. Melanie held several management positions with Owens Corning Fiberglas before retiring as Director of Information Systems in 1993.

Since then, Melanie has been an active school volunteer in all the districts where her family resided, including Louisiana, California, Georgia and Michigan. Her favorite role has been volunteer math tutor, acting in this capacity in all four states.

IDEAS FOR HOW MATH VOLUNTEERS CAN BE LEVERAGED
Melanie Kurdys 3/2006

Over the years, public schools have developed many organized methods for using reading volunteers, to the benefit of students and teachers. However, most school districts do not use volunteers for math, perhaps because few people approach the school to offer these services. But it is also possible that schools have not developed a comfortable means by which to integrate the skills of math volunteers into their daily routine. Here are some different experiences I have had as a math volunteer over the years in districts in Louisiana, California, Georgia and Michigan.

1) ONE-ON-ONE OUTSIDE OF SCHOOL FOR TEACHER IDENTIFIED STUDENTS
One elementary school created a list of students who needed assistance in math and other areas, with parental permission. Parents who wanted to help chose a student or two from the list depending on the child's need and the volunteer's skills. We were encouraged to meet with our student once or twice a week after school, preferably in the student's home, but that was not required. The idea was to tutor or help with homework in a place where the student would be comfortable and perhaps develop a routine for themselves when the volunteer was not available.

I tutored a boy in math, helping him with homework and drilling multiplication tables. I tried using games and treats as incentives. The home was too dysfunctional to create the result desired, but we developed a good relationship and I still maintain correspondence contact with the boy and his mother. This is a very personal process and may not be embraced by many children and parents who need help.

2) GROUP WORK IN SCHOOL FOR TEACHER IDENTIFIED STUDENTS
One elementary teacher invited me to come in twice a week to work with 3 particular students who were having trouble keeping up. I usually worked from worksheets developed by the teacher which focused on problem areas from that week or perhaps the week before. We also regularly practiced multiplication tables.

3) ONE-ON-ONE IN SCHOOL FOR STUDENTS WHO SELF-SELECT
Anther elementary teacher of more advanced students invited me in the day before a scheduled test and then again the day after. The students signed up on a list if they wanted help from me. I sat just outside the room and met with them one at a time to discuss particular areas they were concerned about. We reviewed the results of their test, to determine what type of mistakes they made and discuss how they could improve.

I especially like this method, as the students take responsibility for their learning. They worked with me because they wanted to, which made them very cooperative. In addition, the teacher and I could gauge the learning pace of the class, summarize common problem areas and develop strategies to make sure everyone was really learning.

4) ONE-ON-ONE IN CLASS FOR STUDENTS WHO SELF-SELECT
A middle school teacher invited me into the classroom twice a week to circulate among the students, surprisingly both as he lectured and as the students worked. I was there to explain one-on-one to whoever had a question. He was also a coach and he had an interesting classroom strategy. He was teaching a required class of average students. He established clearly defined check-points for the class where he said we would not move ahead until everyone in the class passed the checkpoint with a minimum of 80%.

He encouraged the whole class, including me, to operate as a team, helping each other to master the lessons. As a person, he was a talented team-builder, so I am not sure every teacher would be comfortable with this approach, but by the end of the year, he and I were certain that every student had mastered the material.

5) ONE-ON-ONE IN SCHOOL CLASS FOR SCHOOL ID'D STUDENT

Again in middle school, a young lady came into our district from the middle east where her people did not teach girls math. She could not count past 100. I met with her four days per week for one semester instead of her regular math class. Her teacher did regular assessments and shared them with me and I moved her through pretty much elementary school math in that time. Obviously, she was a smart girl with an excellent attitude toward learning, but this was a special need that clearly was better met with one-on-one help.

I had another assignment similar to this, except my contact was the principal, not the teacher. After about two months of working with the student, I determined he was right on track with his math learning, but was not consistent in doing his homework and had trouble following verbal directions from the teacher. The teacher refused to allow the student to come to me for help because my assessment differed from hers. I understand the student was assigned to a new teacher.

6) GROUP WORK AFTER SCHOOL FOR STUDENTS WHO SELF-SELECT

My high school aged children have offered to work with other students in their class or similar classes when the other students are having trouble. We would run study groups in my kitchen where I make snacks and am available to help as needed. I think this works especially well with high school kids because they are sensitive to peer perception, especially students who have been successful learners all their lives. I am not "tutoring" in their minds. This is informal and may be tricky to establish in an organized fashion, but I think it is a useful idea to consider.

Many combinations of these strategies could also work. Some important issues to consider are:

- Teachers need to be responsive and comfortable in using volunteers. Examples 2, 3 and 4 were all ideas developed by the teachers with very successful results.
- Volunteers need to understand the teacher's goals and strategies. They need to jointly agree on teaching styles. Open, regular communication between the teacher and volunteer is very important.
- I am a strong advocate of self-selection for middle and high school students. Perhaps elementary students are not yet mature enough to be responsible for their own learning and need teacher directed intervention. I really do like the idea of bringing parents of younger students who need help into the solution, but since I am not a social worker, I am not really sure how to accomplish that. Perhaps there are successful models somewhere that we could look at.

There was one circumstance where I had to quit in-class tutoring because I disagreed with the approach the teacher was using. Clearly the teacher has the right to determine his own approach within the guidelines of their District, but volunteers need to be comfortable as well. A gracious "out" is a nice process to consider.

MATH CURRICULUM REVIEW
RESEARCH ON
"AFTER HIGH SCHOOL" MATH EXPECTATIONS
FINAL REPORT 3/2006
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American Educator Fall 2005
www.aft.org/pubs-reports/american_educator/issues/fall2005

Here are the comments documented from our conversation after the presentation from March 16, "After High School Math Expectations". There are three categories:

- Response required
- Comment, no action needed
- Open, consider additional research or discussion

Response Required

- Our numbers need to be accurate/ relevant if it is used
- How to use a calculator (k-6)- not use it all of the time
- How did they find the mean for ACT- relative to which course of study?
- Remedial courses- how many are taking that because that is all that is required?
- Parents often push for calculus- not realizing that this may not be appropriate
- Is there a rush to calculus that is a detriment to knowing algebra—
  (perhaps there is a chronological association between success in Geometry)
- Academically struggling students may need remedial coursework

Comment

- Agree with depth- not breadth
- EL (agree with need for specialty teachers)
- Not getting a deep understanding
- Need real world connections!
- Parent education piece is critical
- ACT were a good predictor this year at WMU for placement

Open

- Disconnect between state and university expectations
  - college wants understanding of algebra
  - state moved algebra to the 6^{th} grade
  - concerned about teaching for depth, what criteria is used?, we have a lack of control over what students take at any level (e.g. LA Plus)
- Colleges- information about our graduates??????
- Differentiated instruction- appropriate content and time/ freedom to teach the concepts/ foundations well
- How will we use this information?
- Where is the breakdown for female math majors (parent education???)
- Understanding the language of math- what should be memorized- understood- how do we accurately assess them?

Responses from M. Kurdys

1) Our numbers need to be accurate/ relevant if it is used

This is absolutely critical if people are to believe the analysis. I went back though the numbers and data sources. The % of graduates who go on to higher education and the % who attend the top five colleges are both sourced from student reported data. There is no outside verification for these numbers. Therefore, I need to be more clear about this and make the numbers less definitive, for example, the report would say:

> "Although this data is student reported and not independently verified, trends show that well-over 50% and as many as 90% of PPS graduates attend or intend to attend post secondary schools. Of those reporting, over 90% attend one of five schools…."

I am concerned that the % distributions of who attends which schools appears more exact than appropriate, again primarily since we are dealing with student reported data, although the distributions from the colleges tends to support the numbers. I plan to change the report to reflect this way…

> "As freshmen, PPS graduates attend the following five schools ranked in order of frequency: 1) KVCC, 2) WMU 3) MSU 4) UM and 5) GVSU. "

It may be construed as vague, but then again, it does not reflect a level of accuracy that is not verified.

Importantly, the numbers in the balance of the report are either from referenced sources or direct from the schools contacted and thus are externally verifiable.

2) How to use a calculator (k-6)- not use it all of the time

There was some question as to the intent of the faculty comment. Most assuredly, calculators should be taught and used in the classroom K-12. The consistent message is that students entering college are too dependent on calculators, which means their use, on balance, has been on the high side. The exact use is clearly a judgment call, but the suggested guideline would be to have homework and tests within the scope of most "chapters" which students are to do without calculators. This way you can test depth of understanding and "fluency" while developing students' confidence to solve math problems with only pencil & paper.

3) How did they find the mean for ACT- relative to which course of study?

When students take the ACT exam, they are asked to complete background information about themselves. One line of questions asks students which classes they have taken or plan to take while in high school. ACT uses these responses along with test scores to create these analyses. They do this for the thousands of students who take the exam all across the country, thus reporting results generated from a very broad population. You can find more information on this research at www.act.org under "What are ACT's College readiness Benchmarks?" Interestingly, the colleges have a high degree of confidence in these findings, which is reflected in their willingness to use the results as a key part of their placement process.

4) Remedial courses- how many are taking that because that is all that is required?

This is an interesting question. It is unlikely that a student who places into an Algebra based course would then take a remedial course. For one thing, they would not receive credit for the course and would have to pay for it at every school considered. KVCC reports that students argue to move up in this category, not down.

At the other end, again it is unlikely a student would put themselves into an Algebra-based course if they placed into Algebra proficient. If they are taking a field of study where additional math is not required, placing into Algebra proficient meets the credit needed, ie, they "place out" of their math requirement and do not need to take anymore math. Why waste time or money on a course not required. If they are in a field of study requiring more math, they would probably move into Trigonometry, Pre-cal or calculus, rather than move back into an algebra-based course. So due to the nature of the three categories, it is unlikely a student would place themselves lower than the college.

5) Parents often push for calculus- not realizing that this may not be appropriate

Having children who have recently graduated who were heading for college, I myself might have been guilty of this. And actually, I was surprised by this result and have talked to other parents. As a matter of fact, my youngest daughter is a KAMSC student and is enrolled in calculus this year. But last summer, I was not convinced her Algebra skills were strong enough for her to really be ready to learn, so I enrolled her in Sylvan Learning for Algebra tutoring. She progressed quickly, but it was clear she really needed the focused study. It is not my place to tell you what to do, but I think this is an important finding and would be good to make clear to parents. In addition, the idea of using an objective "calculus readiness" test, that students would have to pass before proceeding might be useful. It would be especially persuading if the model for the test came from a college!

6) Is there a rush to calculus that is a detriment to knowing algebra—
(perhaps there is a chronological association between success in Geometry)

Again, as in the previous point, I think this is very important. Finding a way to assess a student's readiness to proceed, aside from just passing a class, is important. It might be reasonable to design some Geometry and Algebra courses in semester blocks to allow students to take, say 3 semesters to "get" Algebra I, for example, if they needed. The student doesn't have to fail the semester to still need more learning before being ready to proceed. Or maybe the third semester is Algebra I/Geometry transition class, so a student could take five semesters to learn Algebra I & Geometry before moving on to Algebra II.

7) Academically struggling students may need remedial coursework

This fits with some of the previous discussion, but it is important to figure into your curriculum design. Where are the key transition points where students REALLY need to know "stuff" before they move on? How do we assess their knowledge? What resources can we allocate: tutors, summer school, online courses?