

**KENTUCKY**  
**EARLY MATHEMATICS**  
**TESTING PROGRAM**

**2007 ANNUAL REPORT**

Submitted to the  
Kentucky Council on Postsecondary Education  
and the  
Kentucky Board of Education

## From the Directors

We have finished a rewarding and productive seventh year as directors of the Kentucky Early Mathematics Testing Program (KEMTP). We are extraordinarily pleased and gratified by the support and cooperation we have received from so many talented people in the mathematics community and the larger educational community throughout the state. We would like to thank these people for all their support and hard work in behalf of the KEMTP. We would especially like to thank the high school mathematics teachers who took the time and effort to give the KEMTP test to their students and to reinforce the message that the testing sends.

The KEMTP is using its resources to add an entirely new dimension to its online testing. The Statewide Mathematics Placement Testing Group, employing the human, financial and technological resources of the KEMTP, has developed a secure, online mathematics placement testing program that can be used *free of charge* by any participating educational institution in the state. We would like to thank members of this group for their enthusiastic participation in this exciting project. The project is discussed in detail in this report.

We are indebted to so many individuals who have strongly supported our efforts that it is impossible to thank them all individually. A few, however, deserve our special thanks. Among them are Paul Eakin and Ken Kubota, leaders of the UK group that develops and supports online testing, Sue Cain from EKU, Diane Williams from NKU, and Linda Mayhew and Linda Howard from ECTC for their leadership of the placement testing project, our CPE liaison and ardent advocate Dianne Bazell, CPE vice president Jim Applegate for his unwavering support of the placement testing project, our legislative champion Rep. Jon Draud (the author and sole sponsor of the legislation creating the KEMTP), and our talented assistant Mary Golden.

We would also like to thank Northern Kentucky University and the University of Kentucky for their strong institutional support of our work and the Council on Postsecondary Education for funding the program.

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## I. Overview

The Kentucky Early Mathematics Testing Program (KEMTP) was created when House Bill 178, written and sponsored by Rep. Jon Draud, was unanimously passed by the 2000 General Assembly. The program offers a voluntary, online mathematics test intended primarily for high school sophomores and juniors in Kentucky. The test provides students an assessment of their mathematical preparation for college early enough so that they can improve their mathematical preparation while still in high school and thereby avoid placement into remedial courses in college and increase their chances of success in college-level mathematics and science courses. The program is funded by the Kentucky Council on Postsecondary Education and is a partnership between Northern Kentucky University (NKU), which administers the program, and the University of Kentucky (UK), which develops and maintains the website. The program began testing in the spring of 2001 and has been testing every semester since then.

The bill requires that *“the public university that conducts the testing program shall submit an annual report to the Kentucky Board of Education and the Council on Postsecondary Education regarding its activities”*. This report is therefore submitted to these organizations by program directors Dan Curtin and Steve Newman from Northern Kentucky University, the public university selected to conduct the testing program.

It’s a little difficult for us to believe that the KEMTP has completed its seventh year, with 6,032 Kentucky high school students from 41 high schools taking the KEMTP test last year.

In this report, we discuss the remarkably rapid development of a secure, statewide online placement testing system using the human, financial and technological resources of the KEMTP. The technology for the system was developed at the University of Kentucky (UK). A developmental mathematics test and the college algebra placement test were developed by a statewide placement testing group. These tests have been put online and have been used for placement since last spring by Eastern Kentucky University (EKU), Northern Kentucky University (NKU) and UK. Elizabethtown Community and Technical College (ECTC) began similar testing last summer. Morehead State University and Thomas More College will use the system in the fall. We hope other postsecondary institutions and adult education centers will join them in taking advantage of this system, offered free of charge to institutions and individuals.

We give some interesting data in a recent national report entitled *The Toolbox Revisited* showing that the highest level of mathematics taken in high school is the strongest indicator of eventual completion of a bachelor’s degree. We also give some interesting data collected at the University of Kentucky and Northern Kentucky University showing the effectiveness of the KEMTP test in predicting final grades in college mathematics courses.

We conclude with a statewide summary of KEMTP testing data from last year, including the overall statewide average, the statewide results by question, and the participating high schools and counties.

## **II. Statewide Mathematics Placement Testing Project**

### **1. A Brief History of the Placement Testing Project**

The KEMTP Advisory Board began preliminary discussions of online placement testing at its March meeting at Centre College in 2006. (The KEMTP Advisory Board consists of college and high school mathematics teachers as well as representatives from the CPE and the Kentucky Department of Education). The central issue discussed at this meeting was whether a secure online test was needed to guarantee that the test taker was indeed the person he or she claimed to be. The consensus was that an online placement test must be secure in this sense so that accurate placement would be assured.

The Statewide Mathematics Placement Testing Group was formed following this meeting. The group consists of mathematics faculty from all eight state universities, including six department chairs; nine community and technical colleges; and two private colleges as well as representatives from the Council on Postsecondary Education (CPE) and adult education. The group developed, discussed, modified and approved a developmental mathematics placement test and a college algebra placement test. It was easy to reach consensus on these two tests since they are based on remarkably similar institutional placement tests that have been given for many years.

Ken Kubota and his colleagues in the mathematical sciences computing group at UK designed the secure online system that supports the statewide placement tests. This system is part of a much more comprehensive UK system that supports the KEMTP, the mathematics and Spanish homework systems at UK, and many other academic projects. The UK system is extraordinarily complex and versatile, and yet remarkably easy to use. Kentucky is indeed fortunate to have such superb system available to support its educational efforts.

### **2. The Secure Testing Process**

Placement tests are given in a computer lab. A testing coordinator with an appropriate UK account sets up each testing session with the specified test, session name, date, time and password. A proctor, who does not need a UK account, sets up the computers using the session name and password, and checks student identification. Students enter their names, last four digits of their social security number, a testing number, and take the test. The format for the test is identical to the KEMTP tests. When they finish the test, they submit their answers, view their results, and are advised as to the recommended mathematics course they should take. Alternatively, the testing coordinator can download a spreadsheet of their results and an adviser can use the results on the spreadsheet to advise them at a later date.

The system is constructed so that students could be tested at a high school or college near their homes and the results could then be used for placement purposes at the postsecondary institution of their choice.

### **3. Rationale for Placement Testing**

Colleges offer a variety of developmental mathematics courses for under-prepared students, generally consisting of prealgebra, elementary algebra, and intermediate algebra. If students' ACT math score is below 18 (19 beginning in 2009), they require

remedial assistance. A developmental placement test, consisting entirely of prealgebra and algebra questions, is more finely grained than the much broader ACT and can provide more targeted placement information, and thus more accurate placement, than using the ACT alone.

All colleges in Kentucky offer a college algebra course. This course is a prerequisite for a bachelor's degree in wide variety of college majors, including majors in any business discipline. If students get an ACT math score of 22 or more, then they are guaranteed placement in a college algebra course at any public college or university in the state because of a statewide placement policy enacted by the CPE in 2004. Students with lower scores than required by the institution they attend can take a college algebra placement test to see whether they have the algebra skills required to succeed in college algebra. A calculus placement test serves the same purpose for a calculus course.

#### **4. Potential Uses for Placement Testing System**

There are a great many potential uses for the placement testing system. High school seniors could be given college placement tests at their high schools and the results could be shared electronically with the Kentucky colleges of the student's choice. Students would not have to make a special trip to a college campus. Any Kentucky college that students chose to attend would honor the placement test results. Similar testing could be conducted for adult education students at any one of the 120 adult education centers in the state.

Every high school and adult education center in the state is already on the list of "schools" on the UK site. This would make implementation of remote placement testing just as easy placement testing on a college campus.

Individual school districts, public and private schools, and adult education centers could design their own tests, put them online on the UK system, and use the secure placement testing portion of the UK site to administer these tests online. We hope that some school districts, public and private schools, and adult education centers will take advantage of this innovative testing method made possible by the UK system.

#### **5. Related Statewide Initiatives**

In the last year alone, there have been extraordinary efforts by leaders in education, business and government to improve education in general and mathematics education in particular. The Developmental Education Task Force and the Science Technology Engineering and Mathematics (STEM) Task Force have made sweeping recommendations for change. In response, the Council on Postsecondary Education (CPE) has proposed raised the bar for college readiness in mathematics from 18 to 19 on the ACT mathematics test and from 18 to 21 on the ACT reading test beginning in 2009. If this proposal is adopted, then institutions will be required to give placement tests to students who do not meet college readiness levels in mathematics, English and reading.

The Developmental Education Task Force recommended that common placement tests be given statewide because such tests would permit institutions to share testing expertise and testing data, and thereby make more accurate placement decisions that will result in greater student success. The placement testing group has already shared testing expertise in the process of constructing a developmental mathematics placement test and a college

algebra placement test. Construction of a calculus placement test is underway. The online testing system is ideally suited for sharing testing data among Kentucky's postsecondary institutions and adult education providers.

### **6. Important Information for High School Personnel About Placement Testing**

High school administrators, counselors and especially high school mathematics teachers should be aware of college placement policies in mathematics in order to advise their students. High school personnel should be aware of the Postsecondary Placement Policy from the Council on Postsecondary Education given in this newsletter. They should also be aware of the different placement levels in mathematics and what courses at these levels are required for different college majors. For example, students intending to major in any business discipline at any public university in Kentucky must take a mathematics course at the level of college algebra or above. These students, even if they are not required to take a developmental algebra course to graduate, often must take such a course in order to take college algebra and thus earn a degree in a business discipline. Likewise, students intending to major in a STEM discipline must take calculus. These students must often take college algebra, precalculus, or both, in college even if they essentially took these courses in high school.

The lesson to be learned is that students must prepare appropriately in their high school mathematics courses for the rigors of postsecondary education. Appropriate preparation allows students the option of pursuing a wide range of college majors without the need for re-taking high school courses in college. Appropriate preparation also provides students a smoother transition to postsecondary education and increases the chances that they will earn a college degree.

## **III. KEMTP Tests and Testing Options**

There are a variety of KEMTP tests and testing options available to teachers and students.

- Teachers can choose either an Algebra I competency test for students who have not taken Algebra II or the more advanced KEMTP test for students who have taken Algebra II and geometry. There are online practice tests that students can use to prepare for each of these tests.
- Teachers can give the test online in the school computer laboratory to all students in a given class during one class period.
- Teachers can ask their students to take the test outside of class, either at home or at school during a convenient time. It is easy for teachers to check their online roll books to determine whether a student took the test. Some teachers offer extra credit for taking the test and additional extra credit for doing well on the test.
- Teachers can give the test in the traditional fashion. The KEMTP supplies all necessary bubble sheets and copies of the test. Some schools use the traditional testing method to give the test to large groups of students simultaneously.

KEMTP tests should prove to be a valuable resource in helping students prepare for the ACT assessment to be given to all public high school juniors in March of 2008. The KEMTP is carefully aligned with the ACT and is offered in the same multiple-choice format. Students planning to take college placement tests using the online system will

find that these online placement tests are offered through the same website as the KEMTP in exactly the same format.

#### IV. Toolbox Revisited

*Answers in the Tool Box*, written by Clifford Adelman of the U. S. Department of Education, was an influential study published in 1999 showing that high school curriculum intensity and quality had the strongest influence on eventual attainment of a bachelor’s degree, stronger than socioeconomic status, parents’ education, high school grades, and scores on standardized tests. Within the curriculum intensity and quality category, *the highest level of mathematics taken in high school has the strongest relationship with ultimate completion of a bachelor’s degree in any college major*. This study is a major factor behind the current emphasis on providing all students with a rigorous curriculum. In particular, it was a major factor behind the decision by the Kentucky Board of Education and the Kentucky Department of Education to make Algebra II a graduation requirement.

*The Toolbox Revisited* is a follow up study published in 2006 that confirms and reinforces the conclusions of the earlier study. The earlier study followed a cohort that graduated from high school in 1982 and the later study followed a cohort that graduated in 1992. Table 1 compares the highest level of mathematics taken in high school with eventual attainment of a bachelor’s degree for both these cohorts.

**TABLE 1**  
**Toolbox Data from 1982 and 1992**

<b>Level of HS Mathematics Attained</b>	<b>Percentage Reaching this Level (1982)</b>	<b>Percentage Bachelor’s at this Level (1982)</b>	<b>Percentage Reaching this Level (1992)</b>	<b>Percentage Bachelor’s at this Level (1992)</b>
Calculus	5.2	82.1	9.7	83.3
Precalculus	4.8	75.9	10.8	74.6
Trigonometry	9.3	64.7	12.1	60.0
Algebra II	24.6	46.4	30.0	39.3
Geometry	16.3	31.0	14.2	16.7
Algebra I	21.8	13.4	16.5	7.0
Pre-algebra	18.0	5.4	6.7	3.9

We hope this information will be useful to school administrators, counselors and teachers in their efforts to persuade qualified students to take more mathematics classes beyond the level of Algebra II, even if these students are not planning on a mathematics intensive major in college.

#### V. Predictive Value of Test

The University of Kentucky (UK) has been gathering data over the last several years that show the remarkable effectiveness of the KEMTP test in predicting the final grades in its college algebra, elementary calculus and calculus courses. Northern Kentucky University



(NKU) collected similar data in its college algebra course with similar results. Altogether, 4,025 students have been involved.

The data show clearly how important it is for students to learn and to *retain* the essential algebra and geometry assessed on the KEMTP test. We hope this will encourage more teachers and school administrators to give the test to their students, and will encourage students to take a mathematics course every year of their high school career, especially their senior year, in order to prepare for the rigors of college mathematics.

The process for collecting data is straightforward. Students are given 12 or 15 randomly selected questions from the KEMTP test on the first or second day of class and their scores are compared with their final grades. Table 2 shows the combined results over two semesters of college algebra at UK. Note that of the 51 students who scored over 70% on the KEMTP test, 43% received a final grade of A, 65% received an A or B, and 78% received an A, B or C. The other rows are read in a similar fashion. Table 3 shows the combined results over two semesters of college algebra at NKU.

**TABLE 2**  
**Spring 2003&Spring 2004 College Algebra at UK: 1119 Students**

<b>KEMTP Test Score</b>	<b>Percent (A)</b>	<b>Percent (A,B)</b>	<b>Percent (A,B,C)</b>	<b>Number</b>
Greater than 70%	43	65	78	51
Between 50% and 70%	25	50	70	279
Between 30% and 49%	15	36	56	411
Less than 30%	6	20	42	378

**TABLE 3**  
**Fall 2003&Spring 2004 College Algebra at NKU: 327 Students**

<b>KEMTP Test Score</b>	<b>Percent (A)</b>	<b>Percent (A,B)</b>	<b>Percent (A,B,C)</b>	<b>Number</b>
Greater than 70%	33	59	74	27
Between 50% and 70%	19	42	56	89
Between 30% and 49%	6	14	29	133
Less than 30%	3	10	27	78

Elementary calculus at UK is required of all business and economics majors. Calculus at UK is required of all mathematics, physics, chemistry, computer science and engineering majors. The KEMTP test was given to 2423 elementary calculus students over four semesters and to 156 calculus students in the spring of 2002. The results are shown in Table 4 and Table 5.

**TABLE 4**

## Elementary Calculus at UK: 2423 Students over Four Semesters

<b>KEMTP Test Score</b>	<b>Percent (A)</b>	<b>Percent (A,B)</b>	<b>Percent (A,B,C)</b>	<b>Number</b>
Greater than 70%	33	50	65	765
Between 50% and 70%	12	26	43	1004
Less than 50%	6	14	30	654

**TABLE 5**  
**Spring 2002 Calculus at UK: 156 Students**

<b>KEMTP Test Score</b>	<b>Percent (A)</b>	<b>Percent (A,B)</b>	<b>Percent (A,B,C)</b>	<b>Number</b>
Greater than 80%	23	54	82	56
Between 65% and 79%	14	34	52	65
Less than 65%	0	9	20	35

## VI. Statewide Testing Results

### 1. Feedback to Students and Teachers.

Feedback to students comes in the form of a letter, delivered either online immediately after test results are submitted if the test is taken online or by the testing program in hard copy form if the test is taken on paper. In either case, students are given their score on the test and an assessment of their mathematical preparation for college based on their score. This assessment is broken into four categories as described in Table 6.

**TABLE 6**  
**Advice Given Students Based on KEMTP Test Score**

<b>KEMTP Test Score</b>	<b>Advice Given</b>
68% to 100% (17-25 correct answers)	Well prepared for entry-level college mathematics course
52%-64% (13-16 correct answers)	Possible need for a remedial course in college
36% to 48% (9-12 correct answers)	Probable need for one, possibly two, remedial courses
0% to 32% (0-8 correct answers)	Probable need for at least two remedial courses

In the same letter, students are urged to improve their mathematical preparation for college by working harder in their current mathematics course and by taking additional mathematics courses while still in high school, especially during their senior year. They are also given the mathematical topic involved in each question and whether they answered this question correctly. This diagnostic aspect of the test helps students determine their mathematical strengths and weaknesses.

The online tests, both the KEMTP test and the KEMTP Junior test, give students additional information about which of the standards in the Kentucky Core Content for Assessment in high school mathematics are covered by each of the questions.

## 2. Statewide Summary of Scores.

There were 3,601 Kentucky high school students who took the KEMTP test. This test is appropriate for those students who have completed Algebra I, geometry, and Algebra II. On the KEMTP website, this test is called the advanced exam. The number and percentage of students of students who scored in each of the four categories is shown in Table 7.

**TABLE 7**

<b>Fall 2006 – Spring 2007</b>		
<b>KEMTP Test Score</b>	<b>Number</b>	<b>Percentage</b>
68% to 100% (17-25 correct answers)	793	22
52% to 64% (13-16 correct answers)	519	14.4
36% to 48% (9-12 correct answers)	771	21.4
0% to 32% (0-8 correct answers)	1518	42

There were 2,461 Kentucky high school students who took the Algebra I competency test, affectionately called KEMTP Junior. On the KEMTP website, this test is called the basic exam. The number and percentage of students of students who scored in each of the four categories is shown in Table 8.

**TABLE 8**

<b>Fall 2006 – Spring 2007</b>		
<b>KEMTP Junior Test Score</b>	<b>Number</b>	<b>Percentage</b>
68% to 100% (17-25 correct answers)	898	36.4
52% to 64% (13-16 correct answers)	425	17.2
36% to 48% (9-12 correct answers)	439	17.8
0% to 32% (0-8 correct answers)	699	28.4

The 3,601 students who took the KEMTP test had an average score was 11.0. For each of the 25 questions on the test, the number and percentage of these students who answered that question correctly is given in Table 9.

**TABLE 9**  
**Summary of Statewide Testing**  
**KEMTP Test**

**Number of Students: 3601**  
**State Average: 11.0**

Question	Number of Students with Correct Answer	Percent of Students with Correct Answer
1. Find slope of a line	1654	45.9
2. Solve linear inequality	1478	41.0
3. Find angle in isosceles triangle	1543	42.8
4. Factor a binomial expression	1918	53.3
5. Factor a quadratic expression	1664	46.2
6. Find volume of a sphere	864	24.0
7. Find equation of a parabola	1798	49.9
8. Subtract rational expressions	1166	32.4
9. Apply laws of exponents	1441	40.0
10. Solve system of linear equations	2161	60.0
11. Add quadratic polynomials	1438	39.9
12. Evaluate a function	2029	56.3
13. Find angle in a triangle	2136	59.3
14. Formulate linear expression	1666	46.3
15. Solve linear equation	2048	56.9
16. Simplify rational expression	1423	39.5
17. Solve proportionality problem	2049	56.9
18. Solve geometric word problem	1756	48.8
19. Apply Pythagorean theorem	1509	41.9
20. Solve quadratic equation	1477	41.0
21. Solve trigonometry problem	910	25.3
22. Translate a graph	1206	33.5
23. Solve probability problem	1281	35.6
24. Solve similar triangles problem	1035	28.7
25. Find slope of a line	1863	51.7

### 3. Participating High Schools and Counties.

The 41 Kentucky high schools that participated in the KEMTP, together with the counties in which these schools are located, are listed in Table 10.

**TABLE 10**  
**Participating Schools and Counties**

<b>Participating Schools and Counties Fall 2006-Spring 2007</b>		
	<b>School Name</b>	<b>County</b>
1	Assumption High School	Jefferson
2	Breathitt County High School	Breathitt
3	Central Hardin High School	Hardin
4	Conner High School	Boone
5	Cumberland County	Cumberland
6	Dixie Heights High School	Kenton
7	Edmonson County High School	Edmonson
8	Fern Creek Traditional High School	Jefferson
9	Grayson County	Grayson
10	Hancock County High School	Hancock
11	Henry Clay High School	Fayette
12	Holy Cross High School	Kenton
13	Jackson City High School	Breathitt
14	Lafayette High School	Fayette
15	Lexington Christian Academy High School	Fayette
16	Louisville Male Traditional High School	Jefferson
17	Ludlow High School	Kenton
18	Mercer County High School	Mercer
19	Mercy Academy High School	Jefferson
20	Metcalf County High School	Metcalf
21	Monroe County High School	Monroe
22	Montgomery County High School	Montgomery
23	Muhlenburg North High School	Muhlenburg
24	Newport Central Catholic High School	Campbell
25	Oldham County High School	Oldham
26	Owen County High School	Owen
27	Owensboro Catholic High School	Daviess
28	Pendleton County High School	Pendleton
29	Prestonsburg County High School	Prestonsburg
30	Rowan County High School	Rowan
31	Ryle High School	Boone
32	Sacred Heart Academy High School	Jefferson
33	Saint Henry High School	Kenton
34	Scott High School	Kenton

35	Seneca High School	Jefferson
36	Sheldon Clark High School	Martin
37	Somerset High School	Pulaski
38	Southwestern Pulaski County High School	Pulaski
39	Spencer County High School	Spencer
40	Walton Verona High School	Boone
41	Western Hills Academy High School	Franklin