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Mathematics Study Part 2: Educator Preparation and Teacher Quality

Research Report No. 369 Part 2

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Mathematics Study

Part 2: Educator Preparation and Teacher Quality

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Foreword

In December 2008, the Education Assessment and Accountability Review Subcommittee directed the Office of Education Accountability to undertake a three-part review of mathematics performance in Kentucky schools. This report is presented in three parts. Part 1 focused on student assessment and evaluation data and trends. Part 2 focuses on preservice teacher education, the accreditation of educator preparation programs, postservice continuing education of teachers, indicators used to measure teacher quality, issues surrounding attracting and retaining mathematics teachers, and measurement of teacher quality. Part 3 will focus on factors associated with high student mathematics achievement and continuing challenges confronting the state as it strives to improve the achievement of all students.

The Office of Education Accountability would like to thank the staff of the Education Professional Standards Board, the Kentucky Department of Education, and the Council on Postsecondary Education for their assistance in completing this report.

Robert Sherman
Director

Legislative Research Commission
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Summary

This report focuses on mathematics teacher quality in Kentucky. It outlines the steps to becoming a mathematics teacher, teacher licensure, educator preparation programs, teacher quality indicators, and broader issues such as compensation and evaluation in attracting and retaining high-quality teachers. The primary agency responsible for teacher licensure and educator preparation program accreditation is the Education Professional Standards Board (EPSB). However, the Kentucky Department of Education and the Council on Postsecondary Education are also entities that affect teacher quality in the state. Collaboration among these three agencies in data collection, program development, and program evaluation is an essential component of efforts to improve teacher quality.

EPSB certifies all teachers and accredits all educator preparation programs in Kentucky. In this capacity, it is the central agency responsible for ensuring the quality of educator preparation programs and graduates of those programs. All educator preparation programs in Kentucky are accredited, and 99 percent of all mathematics teachers have met the educational requirements and passed content knowledge examinations established by EPSB to become certified. Yet concerns about the quality of mathematics instruction are voiced by administrators across the state and mathematics assessment data show little annual improvement in student mathematics performance. At present, a data system needed to evaluate teacher quality and educator preparation quality is not available.

The Education Professional Standards Board has been proactive in responding to research-based findings regarding mathematics instruction. It is currently implementing an elementary endorsement in mathematics. An endorsement is not linked to compensation, but it signifies that a teacher has taken specialized course work and training in the endorsement subject matter. EPSB also is working with the Kentucky Department of Education and the Council on Postsecondary Education on a P-20 data warehouse and redesigning master of arts in education programs to focus on teacher leadership.

Teacher Standards

All certified mathematics teachers in Kentucky must pass Praxis II pedagogy and content knowledge examinations. Analysis of Praxis II data shows that the median Praxis II content knowledge examination scores for Kentucky teachers are similar to the national median on each test. EPSB sets the minimum passing score for all Praxis II exams by using a methodology approved by the testing company. Research has shown that higher passing scores could negatively affect the supply of all mathematics teachers in Kentucky, especially minority teachers. EPSB is reconsidering both the use of the Praxis II examination and the appropriate passing scores of any teacher examination upon implementation of 2009 Regular Session Senate Bill 1.

Recommendation 2.1

The Kentucky Department of Education should annually review and report the results of the Minority Educator Recruitment and Retention Scholarship program that was created to develop minority educators in science, technology, engineering, and mathematics.

Reports should include participation by educator preparation program, the rates of program completion, employment by content area, and the efforts of districts to recruit minority educators.

Recommendation 2.2

The Education Professional Standards Board should evaluate the standards measured by mathematics exit exams required for mathematics certification and ensure that the selected exit examinations and passing scores adequately reflect the content knowledge and pedagogy skills expected of all teachers.

Educator Preparation Programs

There are 28 accredited educator preparation programs in Kentucky. EPSB has formed a partnership with the National Council for Accreditation of Teacher Education to evaluate the quality of each educator preparation program. Despite the accreditation system, researchers are unable to measure the impact of a program's graduates on student achievement. At present, it is impossible to link individual teachers to their educator preparation programs. This would be an important component of a higher education accountability system and would support the development of best practices in teacher education.

Recommendation 3.1

The Education Professional Standards Board, in collaboration with the Council on Postsecondary Education, the Kentucky Department of Education, and the Education and Workforce Development Cabinet, should require that sufficient data be included in the P-20 database that would permit value-added assessment of educator preparation programs that is more content and program specific than the current National Council for Accreditation of Teacher Education and state accreditation requirements.

Special education teachers are responsible for collaborating with classroom teachers in mathematics and for leading self-contained classrooms in mathematics instruction. Since 2000, more than 7,500 special education teachers have been approved to teach through emergency certification or alternative certification routes in Kentucky. However, most special education teacher training programs require minimal mathematics content knowledge and few mathematics pedagogy courses despite the fact that special education teachers are generally certified to teach from preschool through grade 12.

Recommendation 3.2

The Education Professional Standards Board and the Kentucky Department of Education should form a joint task force to address the specific needs and challenges of teaching mathematics to special education students. This analysis should include a review of current literature and best practices on the instruction of mathematics to special education students and a review of the mathematics course work requirements of special education teacher training programs and master's programs in Kentucky. Findings and recommendations should be presented to the Education Assessment and Accountability Review Subcommittee by June 30, 2011.

In general, the minimum number of required mathematics content knowledge courses for middle school and secondary teachers is considered sufficient. Site visits made by Office of Education Accountability staff found that most principals and administrators believe that their mathematics teachers possess adequate content knowledge. The greatest perceived deficiency in mathematics instruction is in content knowledge pedagogy. A study by mathematics specialists from the University of Louisville found wide variation in the coverage of critical content of middle school mathematics courses across six educator preparation programs. Teachers must be able to explain complex algorithms in multiple ways to students. Otherwise, mathematics instruction becomes a process of memorization, and students fail to build a strong conceptual framework that is needed to understand abstract mathematics.

Recommendation 3.3

The Education Professional Standards Board and the Kentucky Department of Education, in collaboration with the Kentucky Committee for Mathematics Achievement, should study the alignment of mathematics content knowledge and pedagogy courses at educator preparation and master's programs to determine if important mathematics content knowledge and research-based teaching skills are provided sufficiently in relevant courses. The findings should address concerns regarding the content and pedagogical preparation of mathematics teachers at both the undergraduate and graduate program levels and should offer recommendations to the Education Professional Standards Board on how programs and program evaluations can be improved. The findings and recommendations should be reported to the Education Assessment and Accountability Review Subcommittee by June 30, 2011.

Elementary teachers are broadly trained to teach language arts, mathematics, science, and reading. National researchers have criticized the lack of focus on mathematics in elementary teacher training programs. EPSB has reacted by establishing an elementary mathematics endorsement that will provide additional mathematics rigor to elementary education programs. However, this report identifies variation in the capacity of educator preparation programs to provide the depth and breadth of mathematics pedagogical content knowledge needed to support stronger mathematics preparation.

Recommendation 3.4

The Education Professional Standards Board should establish rigorous review and approval procedures for institution requests to implement elementary mathematics endorsement programs by requiring proof of program capacity to provide the level of instruction required, which includes having sufficient mathematics specialists on staff.

All teachers in Kentucky are required to earn a master of arts in teaching within 10 years of certification. Recent literature has questioned the value of master's degrees in producing more effective teachers. EPSB has responded by redesigning the traditional master of arts in education degree. The redesign focuses on teacher leadership and requires teachers to tailor their course work to their individual growth plans.

Recommendation 3.5

The Education Professional Standards Board should develop program evaluation methodology and a time line for measuring the impact of the Teacher Leader Master's Program by June 30, 2011. The methodology should include data that permit detailed analysis at a content and program level.

Teacher Quality Attributes

Chapter 4 of this report analyzes indicators of teacher quality commonly assumed to be important gauges of teacher knowledge and ability. The review covers teacher experience, teacher certification, master's degrees, teacher literacy, and content knowledge. Kentucky data, when available, are presented for each attribute. This chapter also reviews three current indicators of quality associated with higher rank and pay in Kentucky: national board certification, pay rank, and years of experience. The literature on teacher quality attributes is reviewed, and the issues of content knowledge pedagogy and mathematics content knowledge are further explored. In general, the research on the impact of many indicators of teacher quality is inconclusive.

Mathematics Teacher Supply, Compensation, and Evaluation

The final chapter of the report examines factors that need to be considered in the teacher quality discussion. At the national level, the supply of mathematics teachers is considered to be low. In Kentucky, principals and administrators report that the supply of mathematics teachers varies from district to district. Wealthy districts and high-performing schools tend to have fewer problems attracting mathematics teachers than do poorer and geographically isolated districts. Currently, the critical shortage report prepared by the Kentucky Department of Education to analyze teacher staffing data is insufficient. More accurate analyses of teacher supply and demand are needed to plan for state staffing needs.

Recommendation 5.1

The Kentucky Department of Education and the Education Professional Standards Board should jointly develop a formula to accurately determine teacher shortage areas, long-term trends, and the future hiring needs of the state. The formula should focus on ensuring that teacher availability and quality are equalized across the state. These agencies should report their findings to the Education Assessment and Accountability Review Subcommittee by June 2011.

Chapter 1

Teacher Quality

Introduction and Overview

In December 2008, the Education Assessment and Accountability Review Subcommittee approved the Office of Education Accountability's (OEA) research plan to study mathematics. One part of that study was to examine mathematics teacher quality. The objectives were to analyze teacher quality variables, including available data on teachers, educator preparation programs, and organizations responsible for ensuring teacher quality standards.

This report focuses on the quality of mathematics teachers in Kentucky. Most researchers agree that quality teaching is critical to improved student performance, but the attributes that make a teacher effective are unknown.

This report focuses on the issue of teacher quality and mathematics education. Kentucky is attempting to improve student performance in mathematics to meet both state performance goals and 2014 No Child Left Behind (NCLB) goals. Multiple mathematics-related initiatives have been implemented at the state and district levels aimed at increasing mathematics proficiency, but performance data continue to show marginal student gains on state assessments. This report looks at a number of teacher quality indicators that researchers have used to gauge teacher quality.

Description of This Study

This study examines preservice teacher education, educator preparation programs, continuing education, and teacher quality indicators.

This study focuses on preservice teacher education, educator preparation program accreditation, continuing education, traditional indicators of teacher quality, and issues surrounding attracting and retaining mathematics teachers and teacher quality accountability.

How This Study Was Conducted

The Education Professional Standards Board (EPSB), the Kentucky Department of Education (KDE), the Council on Postsecondary Education (CPE), and Kentucky independent colleges provided some of the data for this study.

To complete this study, staff analyzed data provided by the Education Professional Standards Board (EPSB), the Council on Postsecondary Education (CPE), the Kentucky Department of Education (KDE), and Kentucky's public and private colleges and universities. In addition, staff conducted an extensive literature review and interviewed national experts who specialize in teacher quality research. Staff also analyzed 50 randomly selected mathematics teacher master's degree transcripts to determine the

amount of course work devoted to mathematics content knowledge and mathematics pedagogy.

Staff conducted 15 site visits to Kentucky districts and schools that were either overachieving or underachieving in mathematics performance when controlling for poverty.

Data are also taken from OEA site visits to 15 school districts. Site visit data include interviews, assessment data, and additional documents related to mathematics teaching and learning. Site visit districts and schools were purposely selected to include programs with higher than expected or lower than expected mathematics academic achievement while controlling for school poverty. To the extent possible, OEA staff attempted to choose a site visit sample that was representative of the state's different geographic regions. This study includes a variety of quantitative data that are presented in charts and tables. However, much of the work is qualitative, and available Kentucky data are presented in light of national studies that have driven the debate regarding mathematics teacher quality.

Organization of the Report

The remainder of this report provides background on the conceptual framework of the study. The major entities involved in promoting teacher quality are introduced, and a brief overview of pertinent statutes and regulations conclude the chapter.

Chapter 2 examines the requirements of becoming a teacher in Kentucky and provides analysis of Kentucky Praxis II examinations for mathematics teachers.

Chapter 3 focuses on undergraduate and graduate educator preparation programs. Educator preparation programs are examined and certified by the National Council for Accreditation of Teacher Education and EPSB. The program requirements for master's degrees are covered, and changes mandated by EPSB in its redesign of education master's degree programs are discussed. The chapter concludes with a brief overview of professional development and its role in teacher quality.

Chapter 4 examines indicators of teacher quality that are linked to teacher compensation in Kentucky such as teacher rank, master's degrees, national board certification, and years of experience. Other indicators of quality such as teacher certification, content knowledge, content knowledge pedagogical skills, test scores, and grade point averages are discussed. Traditionally, these measures have been used as proxies for teacher quality, but research has not shown that these teacher quality indicators have a strong positive impact on student performance.

Chapter 5 covers a variety of issues that affect teacher quality outside the purview of EPSB or educator preparation programs. Certain efforts to improve the quality of mathematics teachers in Kentucky may have an impact on teacher supply. For instance, any attempts by EPSB to increase certification standards for potential teachers could exacerbate mathematics teacher supply shortages. Any measure to improve teacher quality will require an integrated approach currently lacking in the state. Critical teacher supply issues could be addressed through evaluation and compensation reform to attract and retain high-quality candidates. Implementing new teacher compensation schemes would likely require comprehensive evaluation models that link teacher quality to student performance. Chapter 5 highlights such evaluation and compensation issues and provides examples of policies and programs implemented in other states to improve teacher quality.

Teacher Quality Defined

The No Child Left Behind Act requires highly qualified teachers in all classrooms. Over 98 percent of Kentucky mathematics teachers are considered highly qualified.

NCLB regulations require all classrooms to be staffed by a highly qualified teacher. Highly qualified means the teacher has a bachelor's degree, is fully certified by an accreditation agency, and demonstrates proof of competency in the subject matter. The latter is usually accomplished by passing a content knowledge test that is a prerequisite for obtaining a teacher certificate. The content knowledge test used in Kentucky is the Praxis II. By these standards, more than 98 percent of Kentucky's mathematics teachers are considered highly qualified for purposes of NCLB. While the highly qualified teacher standards might be indicators of potential teacher quality, they do not guarantee a quality teacher.

Measuring teacher quality remains difficult. Researchers agree that robust data systems that link individual students to individual teachers are required to better understand the interaction of teacher attributes and student achievement.

Researchers have not developed an agreed-upon or quantifiable definition of teacher quality, but most agree that quality teaching is associated with higher levels of student learning. However, emerging methodologies for linking individual teachers to individual student progress are contentious and require robust data systems with valid student-level data. As a result, research has been dependent on easily quantified variables such as teacher years of experience, teacher rank, teacher licensure, and educational attainment as proxies for teacher quality. The correlations between these variables and teacher quality are weak.

EPSB has analyzed mathematics teacher quality in the past and concluded that middle and secondary school teachers have ample mathematics content knowledge. There is concern over the depth of mathematics knowledge of elementary teachers.

EPSB has initiated studies on teacher quality that concluded that most of Kentucky's middle and high school mathematics teachers are well qualified but that university mathematics courses targeted to elementary teachers lack sufficient depth of knowledge (Hibpshman. "A Brief"; Hibpshman "Considerations"). Other studies on teacher quality in Kentucky have found that Kentucky compares well to other states in terms of teacher preparation and quality (Clements. "Kentucky Teachers").

Educator Preparation

Some researchers consider teaching to be a profession that requires mastery of a specific body of knowledge.

Education research is divided on the role of teacher education programs in producing high-quality teachers. Some education researchers consider teaching a profession, like law, that requires mastery of a specific body of knowledge that is fundamental to promoting sound teaching practices (Levine). This perspective contends that colleges of education are responsible for providing the pedagogic, content, and philosophical training for the teaching profession.

Another school of thought considers teaching a craft that can be learned on the job through mentoring. Critics of traditional educator preparation programs want to open up the field of teaching to individuals without education studies backgrounds.

Critics of this viewpoint contend that traditional educator preparation programs are outmoded and largely responsible for a perceived decline in teacher quality. Some researchers argue that educator preparation programs lack rigor and attract students with low academic aptitude (Levine). Others consider teaching a craft that should be opened up to college students who do not choose a major in education studies. This would enable high-performing college students to enter the teaching profession with minimal barriers (Hanushek. "School"). Critics of teacher education also contend that licensure exams, the certification process, and the completion of core education classes restrict the supply of teachers with strong content knowledge skills. Departing from the traditional certification process would require a more aggressive evaluation system that would remove ineffective teachers prior to their attainment of tenure.

Education Professional Standards Board

EPSB is responsible for setting educator preparation program requirements and certifying teachers.

EPSB is the oversight agency for professional educators in Kentucky. It establishes the requirements for educator preparation programs and for teacher certification. EPSB is responsible for

- establishing standards for obtaining and maintaining a teaching certificate (16 KAR 1:010);
- establishing standards and requirements for obtaining and maintaining a teaching certificate and for programs of

- preparation for teachers and other professional school personnel (16 KAR 5:010);
- establishing the standards for admission to an educator preparation program (16 KAR 5:020);
 - evaluating competency and proficiency that might have been attained in some manner other than college preparation (16 KAR 5:030);
 - establishing the standards for admission, placement, and supervision in student teaching (16 KAR 5:040);
 - establishing guidelines under which institutions may develop master's degree programs leading to a provisional teaching certification and a Rank II classification (16 KAR 5:050); and
 - promulgating administrative regulations establishing the standards and procedures for a university alternative certification option for teacher and administrator certification (16 KAR 9:080).

In these capacities, EPSB plays a key role in shaping the quality of educator preparation programs and in determining who is allowed to teach in Kentucky. At present, EPSB is managing a redesign of education master's degree programs in Kentucky colleges and universities.

Over the last 5 years, EPSB has experienced reductions in personnel, operating, and program budgets. EPSB's budget declined from \$11.6 million in fiscal year 2005 to \$9.9 million in FY 2009. The total number of full-time and interim staff declined from 41 to 38 during this same time period and 9 part-time staff positions were lost (Commonwealth. Legislative).

Council on Postsecondary Education

CPE also plays a role in promoting high-quality academic training at educator preparation programs.

The Kentucky Council on Postsecondary Education has several responsibilities to ensure a well-coordinated and efficient postsecondary and adult education system. CPE is responsible for

- developing and implementing a strategic agenda for the postsecondary and adult education system that includes measures of educational attainment, effectiveness, and efficiency;
- producing and submitting a biennial budget request for adequate public funding for postsecondary education;
- monitoring and approving tuition rates and admission criteria at public postsecondary institutions;
- defining and approving all academic programs at public institutions;

- ensuring the coordination and connectivity of technology among public institutions; and
- collecting and distributing comprehensive data about postsecondary education performance.

CPE has the authority to define and approve all academic programs at public universities, and it considers the quality of elementary and secondary education a central responsibility of the postsecondary system.

The mission of CPE is broad, but the organization plays an important role in teacher quality through its authority to define and approve all academic programs at public universities. It does not have authority over independent and private colleges. CPE acknowledges that the quality of elementary and secondary education is a central responsibility of the postsecondary education system (Commonwealth Council). Stronger partnerships between CPE, KDE, and EPSB will be required to design more effective educator preparation programs.

Overview of Mathematics Teachers in Kentucky

EPSB certifies mathematics teachers at the middle and secondary levels. Elementary teachers are considered generalists and receive a general teaching certificate.

EPSB certifies teachers in mathematics at the middle and secondary school levels. Elementary teachers receive a general teaching certificate, not a specific content area certificate; therefore, all elementary teachers are potential mathematics teachers. The breakdown of mathematics teachers in Kentucky by certification level is shown in Table 1.1. These data include all elementary classroom instructors and mathematics instructors in middle and secondary schools. The number of students in each of these school groupings is also included. Because class configurations vary across schools, the most common school groupings are used in the table.

Overall, almost 50 percent of classroom teachers work in elementary schools. In 2007-2008, Kentucky produced 1,193 elementary education majors out of a total 2,168 education degrees (Commonwealth Council). In the 2009 school year, about 23 percent of classroom teachers in middle school taught a mathematics course, and 17 percent of secondary teachers taught a mathematics course.

Table 1.1
Mathematics Teachers by School Grouping

Variable	Elementary (K-5)	Middle School (5-9)		Secondary (8-12)	
	Total	Total	Math	Total	Math
Total teachers	16,428	6,628	1,365	10,308	1,779
Total students	255,232	147,560		196,323	
Student/teacher ratio	15.53	22.26	108.10	19.05	110.36

Source: Staff compilation of Professional Staff Data from the Kentucky Department of Education and Local Educator Assignment Data from the Education Professional Standards Board.

About 50 percent of classroom teachers work in elementary schools. In 2008, about 55 percent of all education degrees were awarded in elementary education.

Table 1.2 shows the total number of education majors by area of concentration in the 2008 school year. At the undergraduate level, about 55 percent of all education degrees were granted in elementary education. The number of secondary education majors is not easily discernable in the data because they are often reported as majors in content areas. At the graduate level, the percentage of elementary, middle, and secondary school master’s degrees is more balanced. The data show that most teachers are pursuing master’s degrees in topical areas outside elementary, middle, and secondary education. The category “Other, non-specific” includes specialty areas such as special education, school administration, and counseling.

Table 1.2
Education Degrees Granted, 2008

	Undergraduate		Master’s	
	#	%	#	%
Elementary	1,193	55.0	412	15.1
Middle	258	11.9	258	9.4
Secondary	---	---	332	12.1
Other, non-specific	717	33.1	1,739	63.4
Total	2,168	100.0	2,741	100.0

Source: Staff compilation of Council on Postsecondary Education data.

Chapter 2

Becoming a Teacher

Introduction

Chapter 2 focuses on the process of becoming a teacher in Kentucky, and it explains the various routes available to those interested in choosing a teaching career.

This chapter focuses on the process of becoming a teacher in Kentucky. It lays out the various routes available to college students and professionals interested in becoming a teacher. The chapter concludes with an analysis of Praxis II examinations used by EPSB to determine minimum thresholds of mathematics teacher content knowledge.

Becoming a Teacher

State law requires that every classroom teacher in Kentucky must hold a valid teaching certificate. EPSB has established multiple routes a prospective teacher can take to become a certified teacher. Most teachers use the traditional route that consists of completing a 4- or 5-year educator preparation program leading to certification. EPSB has also promulgated regulations outlining seven alternative routes that lead to teacher certification for professionals who lack a traditional education studies degree.

New teachers are required to complete the Kentucky Teacher Internship Program (KTIP) to ensure that inexperienced teachers can develop growth plans, create lesson plans, assess students, and conduct parent conferences.

Upon completion of an educator preparation program and all other requirements, EPSB issues teacher candidates a statement of eligibility. This allows a new teacher to be hired for 1 year to complete the Kentucky Teacher Internship Program (KTIP). KTIP requirements are set out in 16 KAR 7:010 and are designed to ensure that teaching interns are nurtured by experienced teachers during their first year and to document that new teachers can fulfill the duties spelled out in Kentucky's teacher standards.

An internship committee is responsible for overseeing the intern's KTIP year. Each committee member observes the teaching intern in the classroom, and a designated resource teacher works one on one with the intern to develop a professional growth plan, create lesson plans, manage classrooms, assess students, and conference with parents. At the end of the internship program, the review committee meets with the intern and renders a professional judgment on the successful completion of the internship.

After certification, teachers are granted a rank. Rank denotes a combination of experience and education and is linked to salary. Novice teachers typically are certified at Rank III.

After successful completion of all teacher certification requirements, an intern is granted a teaching certificate. Each teacher is designated a rank that ranges from Rank IV (lowest) to Rank I (highest). Teacher rank combined with years of teaching experience is used to establish compensation on each district's single salary schedule. New teachers with a bachelor's degree are compensated as a Rank III during their KTIP year, and teachers with emergency certification are considered Rank IV. Teachers who complete a master's degree prior to receiving certification start at Rank II on the pay scale. In order to move up in rank, teachers are required to continue their education and meet the regulatory requirements of 16 KAR 2:010(3). Upon receipt of a master's degree, a teacher achieves Rank II status and higher pay. Those teachers who go on to obtain additional education and degrees can progress to Rank I pursuant to 16 KAR 8:010.

Traditional Route

The traditional route to becoming a teacher is the completion of a 4-year baccalaureate degree at an educator preparation program.

The most common route to obtain teacher licensure is completion of a 4-year baccalaureate degree at an educator preparation program. Upon completion of the program, a candidate applies to EPSB for certification. EPSB requires each candidate to

- submit copies of all academic transcripts, including verification of completion of an accredited teacher preparation program,
- successfully complete KTIP,
- document prior teaching experience,
- submit proof of passing score on the required Praxis II tests, and
- pass a criminal background check.

After the candidate submits all the required information, EPSB staff reviews the application for compliance with regulation and makes a certification decision. Once granted, the teaching certificate is valid for 5 years. After that, the teacher must meet the renewal requirements set out in 16 KAR 2:010.

Continuing Education Option

The Continuing Education Option allows educators to achieve rank change. In general, participants must complete a minimum of 30 semester hours in a planned program that focuses on school leadership.

As set out in KRS 161.1211, teachers can achieve rank change by completing a master's degree or by completing 30 semester hours of equivalent continuing education credits. Rank change is not granted for taking a mix of randomly selected continuing education courses. According to EPSB, rank change is granted only after the completion of a planned program that enhances, adds to, or advances a base certificate.

Educators can enroll in the Continuing Education Option (CEO) as a means of achieving rank change. EPSB suspended enrollment in the program in November 2007 to make improvements, but the program will accept new applicants by January 2010. The newly redesigned CEO will focus on aligning continuing education with school leadership.

The CEO is specifically linked to the participant's school and district and is aligned with Kentucky teacher standards. Details of the CEO can be found in 16 KAR 8:030.

Planned Fifth-Year Program

The Planned Fifth-Year program is an option for teachers who do not pursue a traditional master's degree in education. The program enables teachers to achieve Rank II by completing 32 hours of graduate-level course work.

The Department of Curriculum and Instruction provides Planned Fifth-Year programs in elementary education, middle grades education, and secondary education for teachers who do not meet the admission requirements of a master's degree program, who need flexibility in the time allowed to complete a program, or who need flexibility to design a selection of courses that is lacking in established degree programs. Educator preparation programs at Eastern Kentucky University, Morehead State University, Northern Kentucky University, the University of Kentucky, and Western Kentucky University offer this option.

In general, the Planned Fifth-Year program combines an undergraduate degree in education with 32 hours of graduate-level course work (16 KAR 8:020). Students consult with an academic advisor to plan an individualized program of study that does not yield a master's degree but satisfies requirements for Rank II salary classification, renews the teaching certificate, and permits entry into a Planned Sixth-Year program.

Alternative Routes

EPSB has designed and approved alternative routes that lead to teacher certification. All the options require a bachelor's degree. Option 6, the university-based route, is the most commonly used.

There are seven alternative routes available to professionals interested in transitioning to the teaching profession. The requirements for each option are covered in 16 KAR 9:010 through 16 KAR 9:080.

Option 1 is designed for a holder of a bachelor's degree with a minimum of 10 years of exceptional work experience and an offer of employment in a school district.

Option 2 is referred to as local district training program certification. It requires a 4-year college degree, exceptional work

experience or 30 hours of course work in a certification area, and successful completion of assessments in a specialty area.

Option 3 permits college faculty with 5 years of teaching experience and a master's degree in a certification area to seek employment at a public school in grades 8-12.

Option 4, adjunct instructor certification, allows a college graduate in a needed subject area to teach part time for up to a year on an annual contract basis.

Option 5 is targeted at veterans of the armed forces. Candidates for this program must have 6 years of active-duty experience, an honorable discharge from the armed services, a bachelor's degree in a certification specialty, and successful completion of EPSB-approved subject matter tests.

Option 6 is the university-based alternative route to certification. It is designed for a holder of a bachelor's or master's degree who meets university admission requirements. Typically, a candidate completes a master of arts in teaching in a specialty area. Educator preparation programs that offer this option must assess a candidate's educational background and develop a plan of course work that adequately prepares the candidate for successful completion of the certification process that corresponds with the candidate's school placement.

Option 7, the university institute alternative route, allows a holder of a bachelor's degree in a field other than education to receive a 1-year provisional certificate. This option is currently offered only at Northern Kentucky University for candidates seeking certification in world languages.

Table 2.1 shows the number of mathematics teachers granted certification by the various alternative routes since the 2001 school year. Teachers certified through the alternative route process have the same rights and privileges as all certified Kentucky teachers. EPSB's database does not flag teachers as alternatively certified; therefore, data on the number of alternatively certified teachers working in the classroom are not available.

All candidates using the alternative route must complete KTIP. Since the 2001 school year, 762 provisional certificates have been granted through Option 6 for middle and high school mathematics teachers.

All candidates for alternative route certification must successfully complete the KTIP program and the required Praxis II tests prior to receiving certification. The most commonly used alternative certification route is the university-based route, Option 6. Most of these candidates earn a master of arts in teaching at an accredited

educator preparation program. Table 2.1 shows that about 7 percent of these candidates seek middle school or secondary school mathematics certification. Special education is the most sought certification type of all alternate route candidates.

Table 2.1
Certificates Granted for Alternative
Certification Routes: School Years 2001-2009

Option	Alternative Route	Total Certificates	Total Middle and High School Math Certificates
1	Exceptional Work Experience	268	21 (7.8%)
2	Local District Training Program	161	0
3	College Faculty Program	391	5 (1.3%)
4	Adjunct Instructor	735	45 (6.1%)
5	Veterans of the Armed Forces	254	n.a.
6	University-based Alternative Route	10,527	762 (7.2%)
7	University-based Alternative Route (NKU)	32	n.a.

Source: Staff compilation of data from the Education Professional Standards Board.

Emergency Certification

In special circumstances, schools can hire qualified candidates who receive emergency certification. New changes by EPSB would limit the use of an emergency certificate to 1 year.

In circumstances when a school has a vacant position and cannot find a qualified individual to hire, 16 KAR 2:120 permits districts to issue emergency certification to individuals who do not meet all the requirements of a specific certification. The district must apply to EPSB for emergency certification approval and must show that it could not find a suitable certified teacher to fill the position. EPSB is changing the regulation to limit the term of an emergency certificate to 1 year, as opposed to current language that allows certification for 3 years. Moving forward, an emergency certified teacher must obtain certification through one of the approved routes within 1 year. For NCLB purposes, a person teaching with an emergency certification is not deemed highly qualified and is considered to be teaching out of field.

Emergency certification has been used to fill middle school and high school mathematics teaching positions.

Some schools have used emergency certificates to hire middle and high school mathematics teachers. Table 2.2 shows that, since the 2002 school year, EPSB reported that 601 middle and secondary school mathematics teachers have been granted emergency certification in Kentucky. EPSB also reported that the number of emergency certifications in mathematics has declined since 2007.

Table 2.2
Emergency Certifications for Mathematics: School Years 2002-2009

Emergency Certification	School Year							
	2002	2003	2004	2005	2006	2007	2008	2009
Secondary Math	62	49	22	38	49	50	38	28
Middle School Math	42	66	33	23	27	33	19	17
Total	104	115	55	61	76	83	57	45

Source: Staff compilation of emergency certification data from the Education Professional Standards Board.

Subject Area Endorsements

Teachers can receive an endorsement in a subject area by taking more undergraduate classes in that area. EPSB has approved a mathematics endorsement for elementary teachers.

Teachers in Kentucky can add endorsements to their base certificate in computer science, English as a second language, gifted education, driver education, reading and writing, instructional computer technology, environmental education, school nutrition, and school safety. The endorsements are not linked to compensation, but they signify that a teacher has taken specialized course work and training in the endorsement subject matter. EPSB has approved an endorsement in elementary mathematics education that demonstrates a teaching candidate has completed more mathematics course work than required for an elementary education degree.

Praxis Series Tests

The Praxis Series tests are used by educator preparation programs to determine content knowledge and pedagogy skills. All middle school and high school mathematics teachers must pass the content knowledge exam. Elementary teachers take general tests that include a section in mathematics.

The Praxis Series tests are developed by the Educational Testing Service (ETS) and are used for a variety of purposes. The Praxis I test is used by educator preparation programs as a tool for screening college students who apply for admittance to education studies. Some programs in Kentucky require the Praxis I exam, but it is not mandatory at all programs. EPSB requires all teacher candidates to take and pass Praxis II content knowledge and pedagogy examinations to receive a teaching certificate. All teacher candidates must pass a general Praxis II test called Principals of Learning and Teaching to demonstrate minimum competency in effective teaching pedagogy. Elementary certification candidates take general content and pedagogy exams that do not focus solely on mathematics content knowledge. Middle school mathematics teacher candidates take the Middle School Mathematics exam. Secondary mathematics teacher candidates take the Math Content Knowledge exam and the Mathematics: Proofs, Models and Problems, Part 1 exam.

After the candidate completes applicable Praxis II exams, ETS sends test results to the candidate, EPSB, and the candidate's

university. Appendix A breaks down each Praxis II mathematics exam by test purpose, score ranges, and concepts and constructs.

Praxis II examinations are the most frequently used tests by states, but 12 states have developed their own teacher tests instead of using a test provided by a vendor.

Praxis II assessments are only one test used by states to assess a teacher candidate's content knowledge and pedagogical skills. Twelve states require teacher candidates to pass state-designed tests of content knowledge. Massachusetts and Georgia are two examples of states that have developed and use their own in-state tests. The Massachusetts Tests for Educator Licensure are criterion-referenced tests aligned with the state's curricular frameworks. The subject area exams are designed to assess the breadth and depth of the candidate's knowledge in the subject area, the candidate's understanding of fundamental concepts of the discipline, and the candidate's familiarity with field-specific methodologies. The Georgia Assessments for the Certification of Educators is an objective-based assessment created by a committee of Georgia educators, content specialists, and university faculty who teach educators.

Educational Testing Services developed a Praxis III test that attempts to gauge a teacher's pedagogical knowledge. The exam requires direct classroom observation, but it is not widely used.

ETS developed a Praxis III exam that attempts to gauge a teacher candidate's pedagogical knowledge and application by direct observation in the classroom. Through the Praxis III process, ETS works with a state's higher education regulatory body to develop an appropriate observation instrument with key categories such as classroom preparation, classroom environment, instruction, and professional responsibilities. Kentucky and most states do not use the Praxis III examination because it is more expensive than other tests.

Setting Passing Scores

States set their own minimum passing scores for Praxis II examinations. EPSB collaborates with educators and experts to set Kentucky's passing scores. EPSB attempts to keep Kentucky's passing scores in line with other Southern Regional Education Board states.

When a state selects a Praxis II test that best meets its assessment needs, it then sets minimum passing scores. Each state's examination requirements, choice of appropriate tests, and passing score is different, as each state has autonomy to choose the combination of required tests and scoring thresholds as it sees fit. In mathematics, states may require the same examination but have different passing scores. EPSB collaborates with educators and experts to set Kentucky's passing scores and attempts to keep Kentucky's passing scores in line with other Southern Regional Education Board states. EPSB also uses ETS guidance when determining the cut scores for Praxis II performance as set out in KRS 161.030.

Praxis II content knowledge exams are not necessarily aligned with Kentucky core content or mathematics curricula.

Praxis content is not necessarily aligned with specific school mathematics curricula, but it is intended to align with recommendations of national studies on mathematics education. EPSB and the National Council for Accreditation of Teacher Education strive to maintain an alignment between content offered in teacher preparation programs and content that may appear on a Praxis II exam.

Reviewing Praxis II Passing Scores

Passing scores are set to reflect a minimum level of academic proficiency and content knowledge. Passing scores are periodically reviewed by EPSB.

EPSB periodically reviews Praxis II passing scores for different subject area tests. In general, Praxis exams are used to determine whether a teacher candidate demonstrates a minimum level of academic proficiency and content knowledge (Commonwealth. Education. Staff Notes). EPSB believes that increasing Praxis II passing scores could reduce the number of qualified applicants for certification, increase the number of emergency and conditional certificates, create teacher shortages, and disparately impact minority teacher candidates (Commonwealth. Education. “EPSB”). EPSB points out that the research on standardized assessments of new teachers’ skills and knowledge as a single predictor of teacher performance is inconclusive.

Middle School Mathematics Passing Scores

Middle school mathematics teachers in Kentucky must pass the Praxis II Middle School Mathematics exam. The passing score in Kentucky is 148, which is comparable to the median passing score of 149.5 for all states that administer the exam.

EPSB sets a minimum required passing score for all required Praxis II assessments. The range of possible scores for Praxis II mathematics exams is 100 to 200. EPSB has set the minimum passing score at 148 for the Praxis II Middle School Mathematics exam. Table 2.3 shows the passing scores established by other states. Middle school mathematics passing scores range from at or below 140 in Nevada, Mississippi, and South Dakota to over 160 in Vermont, Arkansas, and Virginia. Of the 34 states and territories that administer the Praxis II Middle School Mathematics exam, 18 states require higher passing scores than Kentucky’s passing score. However, Kentucky’s passing score is close to the median passing score of 149.5 for all states administering the examination.

Table 2.3
Minimum Passing Score on the Praxis II:
Middle School Mathematics Exam by State, 2009

State	Minimum Passing Score	Difference From Median Passing Score
VA	163	+15
VT, AR	161	+13
CT, KS, MO, RI	158	+10
IN, OR	156	+8
MD, WA, MN, WY, NJ	152	+4
NH, PA	151	+3
ID	150	+2
SC, AL	149	+1
US Median	149.5	-
LA, ME, ND, WV, DE, KY	148	-1.5
AK, UT	145	-4.5
HI, OH, TN	143	-6.5
NC	141	-8.5
MS, SD	140	-9.5
NV	139	-10.5

Source: Educational.

Secondary Mathematics Passing Scores

Secondary mathematics teacher candidates must pass two Praxis mathematics-specific exams: Content Knowledge and Proofs, Models and Problems, Part 1. The Content Knowledge passing score in Kentucky is 11 points lower than the US median passing score.

EPSB requires secondary mathematics teacher candidates to pass two Praxis II examinations: Mathematics Content Knowledge and Mathematics: Proofs, Models and Problems, Part 1. Table 2.4 shows that Kentucky's minimum passing score of 125 on the content knowledge exam is lower than the minimum passing score in most other states. The median passing score for states requiring the content knowledge exam is 136.

Table 2.4
Minimum Passing Score on Praxis II:
Mathematics: Content Knowledge Exam by State or Territory, 2009

State	Minimum Passing Score	Difference From Median Passing Score
CO	156	+20
VA	147	+11
AK	146	+10
DC, DE, VT, MD	141	+5
ND, OR, OH	139	+3
UT	138	+2
KS, MO, NJ, CT	137	+1
PA, WY, HI, IN, TN	136	0
US Median	136	-
WI	135	-1
WA	134	-2
WV, NV	133	-3
SC	131	-5
LA	130	-6
ID	129	-7
NH	127	-9
AL, ME	126	-10
MN, KY, AR, VI	125	-11
Guam	124	-12

Source: Educational.

Only eight states and the District of Columbia administer the Proofs, Models and Problems, Part 1 exam. Kentucky's passing score of 141 is 3 points lower than the US median passing score of 144.

Only eight states and the District of Columbia require mathematics teacher candidates to take the Mathematics: Proofs, Models and Problems, Part 1 exam. Passing scores range from a low of 137 in South Carolina to a high of 171 in Alaska. Kentucky's passing score of 141 is 3 points lower than the median passing score of 144. Table 2.5 lists the passing scores for where the exam is required.

Table 2.5
Minimum Passing Score on Praxis II:
Mathematics: Proofs, Models and Problems Exam by State, 2009

State	Minimum Passing Score	Difference From Median Passing Score
AK	171	+27
UT, DC	159	+15
VT, DC	154	+10
OR, AR (US Median)	144	-
KY	141	-3
NH	140	-4
SC	137	-7

Source: Educational.

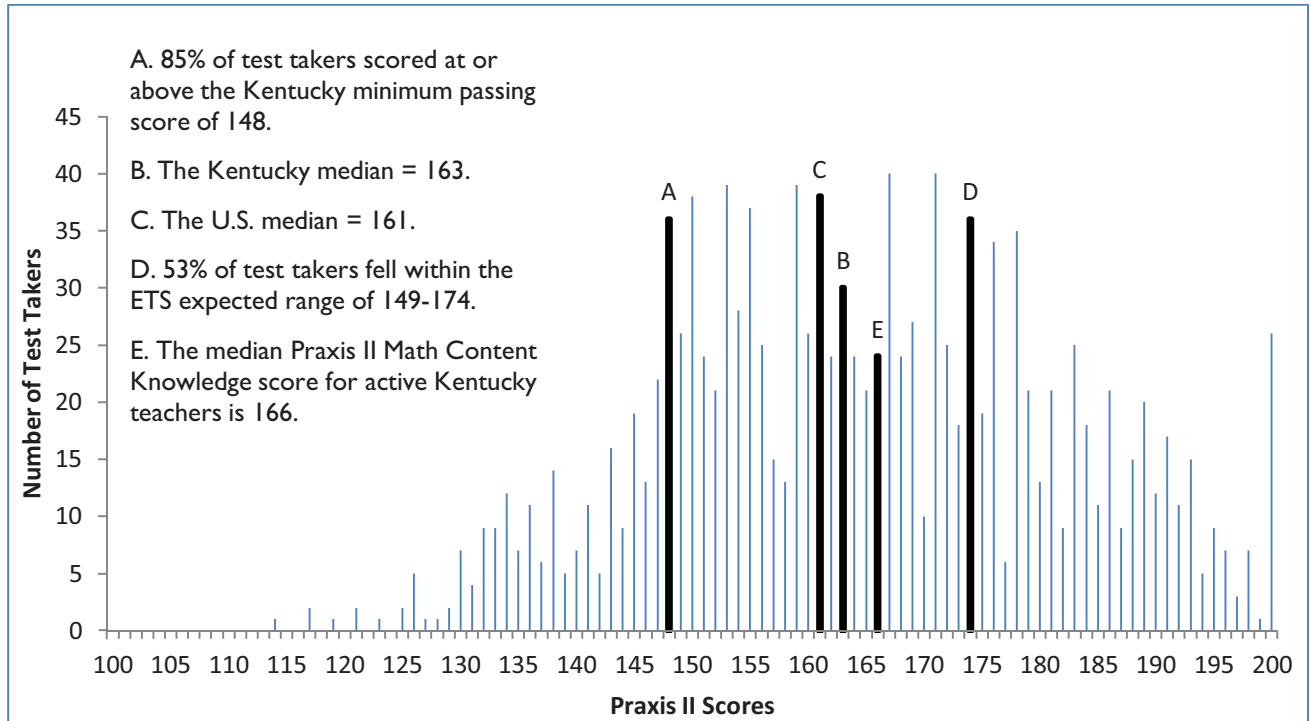
Praxis II Performance

Praxis II data on all active mathematics teachers in Kentucky are not available. Teachers certified before implementation of Praxis II requirements in 1992, those who have transferred from out of state, and those teaching on provisional certificates are not necessarily included in the database.

Complete Praxis II data on all active Kentucky mathematics teachers are not available. Teachers certified prior to the implementation of Praxis II requirements in 1992, teachers who have transferred from other states, and new teachers who are provisionally certified and completing their training while teaching often do not have Praxis II mathematics scores in their electronic certification records. In addition, elementary education teachers are not required to take a mathematics content knowledge exam. However, EPSB provided OEA staff a database that included Praxis II scores for 820 middle school teachers and 610 secondary teachers. The database includes new and veteran teachers and accounts for approximately 50 percent of currently active middle and secondary school mathematics teachers.

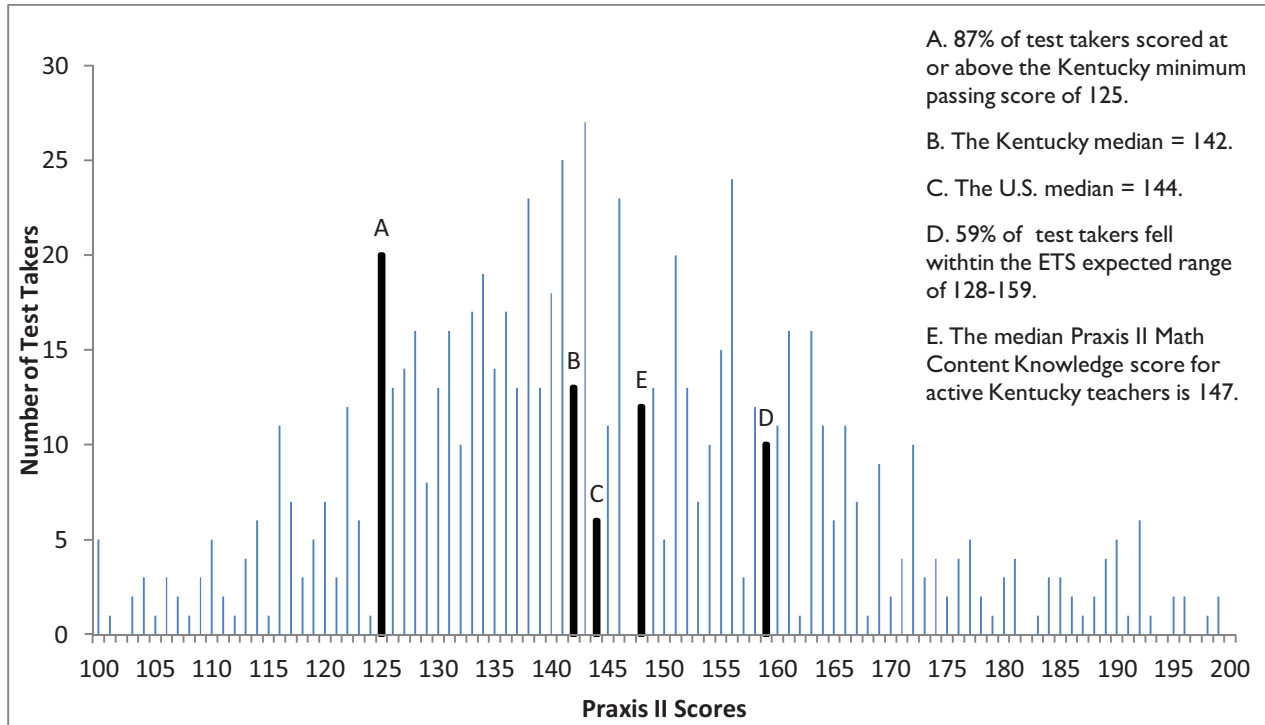
Figures 2.A through 2.C present Kentucky Praxis II data regarding performance of prospective mathematics teachers on the Mathematics: Proofs, Models and Problems, Part 1 exam; the Mathematics: Content Knowledge exam; and the Middle School Mathematics exam.

Figure 2.A
Kentucky Praxis II Middle School Mathematics Exam Distribution for All Test Takers
2004-2008
(626 total test takers)



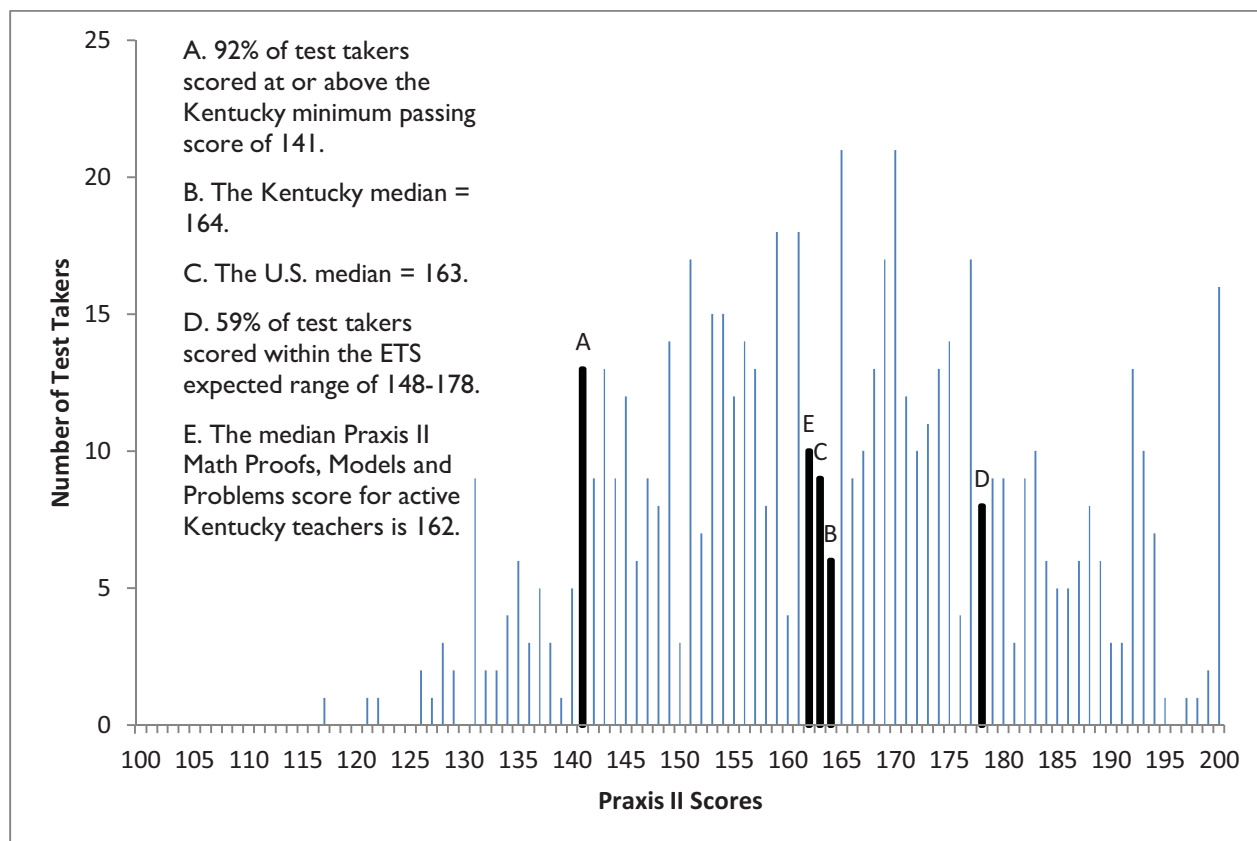
Source: Staff compilation of Educational Testing Service Praxis II data for Kentucky.

Figure 2.B
Kentucky Praxis II Mathematics Content Knowledge Exam Distribution
for All Test Takers, 2004-2008
(757 total test takers)



Source: Staff compilation of Educational Testing Service Praxis II data for Kentucky.

Figure 2.C
Kentucky Praxis II Mathematics: Proofs, Models and Problems Exam Distribution
for All Test Takers, 2004-2008
(626 total test takers)



Source: Staff compilation of Educational Testing Service Praxis II data for Kentucky.

Analysis of Praxis II examination results shows that Kentucky teacher performance on the content knowledge examinations is similar to performance of the nation as a whole.

The distributions in the three graphs above show that prospective mathematics teachers' content knowledge, as measured by the tests, is most often at or above the minimum passing score set by EPSB. The graphs also show that test results in Kentucky are similar to those of the nation. Even though the minimum cut scores selected by Kentucky are typically below the national average, mean test scores for Kentucky test takers are much higher than the established cut scores.

All teachers must pass the Praxis II Principles of Learning and Teaching exam that focuses on general pedagogical knowledge.

In addition to the appropriate Praxis II content knowledge exams, EPSB requires all prospective teachers to successfully complete the Principles of Learning and Teaching exam. This test gauges a prospective teacher's general pedagogical knowledge, not mathematics-specific pedagogical content knowledge.

Retaking Praxis II Examinations

Teacher candidates who fail a Praxis II examination are allowed to retake the test until they receive a passing score.

According to 16 KAR 6:010(7), teacher candidates who fail a Praxis II examination are allowed to retake it multiple times until they receive a passing score. The database provided by EPSB includes records for active certified teachers who initially failed Praxis II exams. Table 2.6 shows that of the teachers who failed a mathematics Praxis exam, the majority failed only once. Of the records analyzed from 2004 through 2008, only 225 failed once and 103 failed multiple times before passing.

Table 2.6
Praxis II Examination Failures by Certified Teachers, 2004-2008

Examination	Total Failed Examinations					
	1	2	3	4	5	6+
Middle School Mathematics Content Knowledge	83	24	4	7	2	0
Proofs, Models & Problems	68	28	7	2	2	4
Total	74	14	7	2	0	0
	225	66	18	11	4	4

Source: Staff compilation of Education Professional Standards Board database.

Impacts of Increasing Praxis II Passing Scores

Raising the Praxis II passing scores might send a signal to educator preparation programs about Kentucky's intent to increase teacher mathematics content knowledge. Higher scores could potentially be a barrier to teaching candidates with low mathematics content knowledge and may have a negative impact on the supply of mathematics teachers, including minority mathematics teachers.

There are two possible benefits associated with increasing Praxis II passing scores. One, an increase would signal to educator preparation programs and teacher candidates that Kentucky is serious about improving teacher content knowledge (Hibpshman, "A Brief"). Two, raising scores could potentially limit the number of teacher candidates with minimal mathematics content knowledge who might otherwise become teachers. Raising passing scores should not have an impact on the distribution of scores shown previously in Figures 2.A, 2.B, and 2.C. However, higher Praxis II passing scores would likely have an impact on the supply of mathematics teachers. EPSB analysis of increasing Praxis II passing scores shows that minority teacher candidates would be most affected by requiring higher passing scores (Commonwealth Education. Staff Notes).

The percentage of mathematics teachers who are African American ranges from 4 percent at elementary schools to 2.6 percent at high schools.

The concern about building and maintaining a diverse teacher corps is reflected in 704 KAR 7:130. Each school district superintendent is required to report annually the school district's recruitment process and any activities used to increase the percentage of minority teachers in the district. As Table 2.7 points out, the percentage of African American elementary teachers in Kentucky is 4 percent. For middle school mathematics and

secondary mathematics, the percentage of African American teachers is 3.5 percent and 2.6 percent, respectively. In general, KDE has declared a critical teacher shortage of teachers in middle school and secondary mathematics. Given this context, concern about how increasing Praxis II scores could impact the pool of possible mathematics teachers is understandable.

Table 2.7
Percentage of Mathematics Teachers by Race
and Grade Level in Kentucky, 2008-2009

Race	Elementary	Middle School	High School
Black	4.0%	3.5%	2.6%
White	95.5%	95.7%	96.1%
Other	0.5%	0.6%	1.3%
Total Number	13,179	1,355	1,779

Source: Staff compilation of the Education Professional Standards Board's Local Educator Assignment Data.

One attempt to increase the number of minority educators is the Minority Educator Recruitment and Retention Scholarship (MERRS). Since August 2001, 435 MERRS participants obtained teaching certificates in Kentucky.

The Minority Educator Recruitment and Retention Scholarship program was authorized by the General Assembly in 1992 to address the shortage of minority teachers in science, technology, engineering, and mathematics disciplines. In each of the last 3 fiscal years, the General Assembly has allocated nearly \$1.7 million for the scholarship program. According to KDE, 435 of the scholarship recipients obtained their teaching certificates between August 1, 2000, and July 31, 2008. Of those, 354 (81 percent) were teaching in Kentucky public schools in the 2009 school year. Data on the number of minority mathematics teachers who had participated in the scholarship program were not available.

Recommendation 2.1

Recommendation 2.1 is that KDE should more thoroughly analyze the MERRS program to determine participation rates by university, program completion rates, content area, and ongoing efforts of districts to recruit minority teachers.

The Kentucky Department of Education should annually review and report the results of the Minority Educator Recruitment and Retention Scholarship program, which was created to develop minority educators in science, technology, engineering, and mathematics. Reports should include participation by educator preparation program, the rates of program completion, employment by content area, and the efforts of districts to recruit minority educators.

For purposes of analysis, staff calculated the impact of raising Kentucky Praxis II passing scores to the national median scores on the middle school mathematics and high school mathematics

content knowledge exams. Raising the passing score on the Middle School Mathematics exam from 148 to 149.5 would have negatively affected 28 teachers in the sample of 820 teacher scores reviewed. It is anticipated that those who scored 148 on the Praxis II Middle School Mathematics exam would be able to increase their scores to 150 with more diligent exam preparation. Therefore, for middle school mathematics, the impact of raising the passing score to the national median passing score would be minimal.

Raising minimum passing scores on the high school content knowledge examination to the U.S. median would likely have an impact on teacher supply. If Kentucky's passing score was 136, about 23 percent of teachers in the database would have failed the examination.

Raising the passing score on the high school content knowledge exam from the current 125 to the national median passing score of 136 would affect 139 out of 610 teachers (23 percent). About 58 percent of examinees scored between 130 and 135. Many of these teachers would likely attain a passing score of 136 with more preparation or additional tests. Some of the remaining teachers who scored at or near 125 would likely struggle to meet the new requirements.

Only eight states and the District of Columbia require the Mathematics: Proofs, Models and Problems, Part 1 exam; therefore, a separate analysis was not performed because the small sample size would not have produced a statistically significant comparison.

If passing scores were increased, educator preparation programs would have an incentive to strengthen their mathematics curricula and student expectations.

Graduates of educator preparation programs should be adequately prepared to fulfill all certification requirements upon graduation. If Praxis II passing scores were increased, institutions would have an incentive to strengthen their mathematics curricula and student expectations.

EPSB acknowledges that passing scores on Praxis II mathematics exams are probably too low. After Senate Bill 1 is fully implemented and new mathematics content standards complete, EPSB will reexamine whether Praxis II is an appropriate assessment for Kentucky teacher candidates and, if so, realign passing scores to meet Kentucky education goals (Rogers. Personal interview).

Recommendation 2.2

Recommendation 2.2 is that EPSB evaluate the standards measured by mathematics exit exams required for mathematics certification and ensure that the selected exams and passing scores reflect the content knowledge and pedagogy skills expected of all teachers.

The Education Professional Standards Board should evaluate the standards measured by mathematics exit exams required for mathematics certification and ensure that the selected exit examinations and passing scores adequately reflect the content knowledge and pedagogy skills expected of all teachers.

Chapter 3

Educator Preparation Programs

Introduction

There are 30 educator preparation programs accredited in Kentucky.

There are 30 accredited educator preparation programs in Kentucky. They are geographically dispersed across the state and include both public and private institutions. Educator preparation programs vary at each institution, some offering only undergraduate degrees, while larger state institutions offer master's and doctoral degrees in education disciplines.

This chapter begins by reviewing the process of becoming a teacher in Kentucky followed by a review of admission criteria and degree requirements of Kentucky educator preparation programs. Mathematics requirements for education majors are analyzed, and problems in mathematics educator training identified in the literature and from staff discussions with mathematics education experts are outlined. Considerable attention is given to the issue of elementary education and the rigor of mathematics requirements in elementary education programs. The chapter concludes with an analysis of students who major in education.

The Role of the Education Professional Standards Board

EPSB has the authority under KRS 161.028 to set standards for, approve, and evaluate college, university, and school district programs for the preparation of teachers and other professional school personnel.

According to KRS 161.028, EPSB has the authority to set standards for, approve, and evaluate college, university, and school district programs for the preparation of teachers and other professional school personnel. This authority enables EPSB to play a critical role in any reform to improve teacher quality. EPSB sets the ground rules for educator preparation programs, but leadership at the schools of education is responsible for implementing program requirements. By statute, educator preparation programs are required to use research-based classroom practices, focus on the subject matter competency of teacher education students, ensure early and high-quality field experiences, develop strong partnerships with local school districts, and demonstrate high performance of their students.

All educator preparation programs in the state must be accredited by EPSB. In addition, a program can also seek to be accredited at the national level by the National Council for Accreditation of Teacher Education (NCATE). Initial state and NCATE program

accreditation is good for 5 years, at which time the program must undergo the complete accreditation process to ensure it meets the most current standards and requirements. Ongoing accreditation for established programs occurs every 7 years.

Educator Preparation Program Accreditation

NCATE and State Accreditation

Accreditation is used by EPSB to maintain standards of quality for all educator preparation programs. EPSB, through a partnership with the National Council for Accreditation of Teacher Education (NCATE), uses NCATE standards to evaluate programs in Kentucky.

Accreditation is a tool used by EPSB to maintain standards of quality across all teacher preparation programs. The program standards EPSB has established for accreditation are included in 16 KAR 5:010 and require that all educator preparation programs in Kentucky be evaluated on the six standards in Table 3.1. Through a joint partnership with NCATE, state and NCATE standards are fully aligned.

Table 3.1
Kentucky Standards for Educator Preparation Programs

Standard 1: Candidate Knowledge, Skills, and Dispositions	Candidates preparing to work in schools as teachers or other professional school personnel know and demonstrate the content, pedagogical, and professional knowledge, skills, and dispositions necessary to help all students learn. Assessments indicate that candidates meet professional, state, and institutional standards.
Standard 2: Assessment System and Unit Evaluation	The unit has an assessment system that collects and analyzes data on applicant qualifications, candidate and graduate performance, and unit operations to evaluate and improve the unit and its programs.
Standard 3: Field Experience and Clinical Practice	The unit and its school partners design, implement, and evaluate field experiences and clinical practice so that teacher candidates and other school personnel develop and demonstrate the knowledge, skills, and dispositions necessary to help all students learn.
Standard 4: Diversity	The unit designs, implements, and evaluates curriculum and experiences for candidates to acquire and apply the knowledge, skills, and dispositions necessary to help all students learn. These experiences include working with diverse higher education and school faculty, diverse candidates, and diverse students in P-12 schools.
Standard 5: Faculty Qualifications, Performance, and Development	Faculty are qualified and model best professional practices in scholarship, service, and teaching, including the assessment of their own effectiveness as related to candidate performance; they also collaborate with colleagues in the disciplines and schools. The unit systematically evaluates faculty performance and facilitates professional development.
Standard 6: Unit Governance and Resources	The unit has the leadership, authority, budget, personnel, facilities, and resources, including information technology resources, for the preparation of candidates to meet professional, state, and institutional standards.

Source: National Council for Accreditation of Teacher Education. Professional Standards.

A board of examiners that has been trained on NCATE standards is responsible for evaluating and accrediting educator preparation programs.

During the state accreditation process, a board of examiners reviews the educator preparation program using NCATE/state standards. The board of examiners is made up of Kentucky education specialists who have been trained by NCATE. Board members include faculty from educator preparation programs, P-12 teachers and administrators, and state and local policy makers. Other constituencies that contribute to the board of examiners include personnel from the Kentucky Education Association, the Kentucky Association of Colleges of Teacher Education, and members nominated by the Kentucky Association of School Administrators; the Kentucky School Boards Association; the Kentucky Association of School Councils; the Kentucky Branch National Congress of Parents and Teachers; the Prichard Committee for Academic Excellence; the Partnership for Kentucky Schools; and subject area specialists in KDE (16 KAR 5:010(13)).

The board of examiners issues one report for Kentucky accreditation. Programs seeking NCATE accreditation receive one report that includes accreditation decisions by both agencies.

If the program review is just for state accreditation, then only one report is issued. If the accreditation process is for both state and national accreditation, then a single report will be issued with accreditation determinations from both agencies. According to EPSB, the two accreditation decisions usually are the same, and the differences between NCATE certification and state certification are minor (Commonwealth. Legislative). In Kentucky, only Union College is currently accredited but with probation. The program was found to be deficient on five of six program standards by EPSB.

Fifteen educator preparation programs in Kentucky have received NCATE accreditation.

Fifteen educator preparation programs in Kentucky are both NCATE accredited and state accredited. As set out in Table 3.2, each preparation program is unique. Seventeen educator preparation programs offer master's degrees, five colleges offer the Planned Fifth-Year program, and seven colleges offer doctoral degrees in education studies. Twenty-two of the institutions with educator preparation programs also offer an undergraduate major in mathematics.

Table 3.2
Kentucky Educator Preparation Institutions

Institution	Education Degrees				Math Major
	Bachelor's	Master's	Fifth-year	Doctoral	
Alice Lloyd College	✓				
Asbury College*	✓	✓			✓
Bellarmino University*	✓	✓			✓
Berea College*	✓				✓
Boyce College**	✓				
Brescia University	✓	✓			✓
Campbellsville University*	✓	✓			✓
Centre College	✓				✓
University of the Cumberlands	✓	✓		✓	✓
Eastern Kentucky University*	✓	✓	✓	✓	✓
Georgetown College*	✓	✓			✓
Jefferson County Public Schools Alternative Certification Elementary and Secondary Program					
Kentucky Christian University	✓				
Kentucky State University*	✓	✓			✓
Kentucky Wesleyan College	✓				✓
Lindsey Wilson College	✓	✓			✓
Mid-Continent University	✓				✓
Midway College	✓				
Morehead State University*	✓	✓	✓		✓
Murray State University*	✓	✓	✓		✓
Northern Kentucky University*	✓	✓	✓	✓	✓
Pikeville College	✓				✓
St. Catherine College	✓				
Spalding University*	✓	✓		✓	
Thomas More College	✓				✓
Transylvania University*	✓				✓
Union College***	✓	✓			
University of Kentucky*	✓	✓	✓	✓	✓
University of Louisville*	✓	✓		✓	✓
Western Kentucky University*	✓	✓	✓	✓	✓

Note: *denotes NCATE accreditation; **Boyce College has met state requirements to establish an education major. The first group of students entered the program in fall 2009; *** Union College is accredited but under probation.

Source: Commonwealth of Kentucky. Education Professional Standards Board. Approved Programs.

Initial NCATE and EPSB program accreditation is good for 5 years. Programs are reviewed every 7 years after initial accreditation.

NCATE accredits 632 programs nationwide and has formed partnerships with all 50 states. NCATE accreditation is touted as a method to ensure program quality based on a set of approved program standards. Nationally, NCATE is the main accrediting body for colleges of education, although a few states use other methods of accreditation. Once accredited, a program is typically reviewed by NCATE every 7 years. Programs that fail to meet NCATE standards can be placed on probation, and if deficiencies are not addressed, accreditation can be revoked.

Accreditation focuses on the quality of the entire educator preparation program. Program accreditation is no guarantee that all components of a program are of equal quality.

It is important to note that NCATE focuses on the quality of the entire educator preparation program and does not focus solely on a discipline such as mathematics. NCATE accreditation does not mean that all components of an educator preparation program are equal in quality. It is possible for a program to have weak mathematics components but to successfully achieve accreditation based on other programmatic strengths. Accreditation simply means that a program has met a quality threshold established by education professionals.

The accreditation reports reviewed in this study suggest that educator preparation programs are evaluated on the merits of the entire program. Universities demonstrate that their graduates are proficient in content knowledge by reporting Praxis II pass rates. This is a weak indicator of performance because Praxis passing scores are based up minimum levels of proficiency; consequently, pass rates are high. At many independent universities, education majors are required to pass Praxis II as a condition for graduation. For this reason, Praxis II pass rates are almost always near 100 percent.

Recent changes in federal reporting requirements promulgated by the Higher Education Opportunity Act of 2008 will require educator preparation programs to report pass rates for all program completers. The new definition of program completers includes all candidates who have completed requirements of the teacher education degree. The definition prohibits educator preparation programs from only reporting data for those it would recommend to the state licensing authority. Therefore, future Praxis II pass rates will accurately reflect the pass rates of all education majors in Kentucky and elsewhere.

For each of the six elements analyzed in the accreditation process, the program is given a ranking of unacceptable, acceptable, or on target.

NCATE standards mirror those listed earlier in Table 3.1. For each component, the program obtains a ranking as unacceptable, acceptable, or on target. The rationale for obtaining NCATE certification in addition to state certification is that the NCATE

evaluation is more rigorous than state certification and includes a stronger peer-review process.

Data Requirements To Measure Program Quality

A P-20 data system is needed to develop a value-added methodology to review the impact of educator preparation program graduates on student achievement.

EPSB is working with CPE, KDE, and the Education and Workforce Development Cabinet to develop a P-20 collaborative data warehouse that will provide myriad data required to develop a value-added measure to review educator preparation programs. The P-20 system is dependent on each organization's systems being fully functional. EPSB's latest \$800,000 request to upgrade its transactional data system was not funded by the General Assembly (Rogers. Interview. April).

The database would enable policy analysts to review an educator preparation program's overall performance and then look at more specific academic units, such as mathematics. EPSB envisions the development of a data dashboard for each educator preparation program and has included this in the Race to the Top funding request (Rogers. "Re: Education Information"). A data dashboard is a user-friendly data interface that would allow users to review educator preparation data such as individual university program completion rates. Theoretically, users could track program graduates to schools and districts. The database is essential for differentiating educator preparation programs and their graduates, a feature that is lacking in the current accreditation process.

Recommendation 3.1

Recommendation 3.1 is that EPSB collaborate with CPE, KDE, and the Education and Workforce Development Cabinet to require that sufficient data be included in the database that would permit value-added assessment of educator preparation programs that is more specific than the current NCATE and state accreditation requirements

The Education Professional Standards Board, in collaboration with the Council on Postsecondary Education, the Kentucky Department of Education, and the Education and Workforce Development Cabinet, should require that sufficient data be included in the P-20 database that would permit value-added assessment of educator preparation programs that is more content and program specific than the current National Council for Accreditation of Teacher Education and state accreditation requirements.

Issues With Accreditation

Critics of NCATE accreditation contend that the process has little value and is used by educator preparation programs to demonstrate prestige.

NCATE has been criticized by national scholars as a "rubber stamp" used by universities to demonstrate prestige (Levine). In reaction to such critiques of accreditation, NCATE is in the process of redesigning the accreditation requirements for educator preparation programs. The major programmatic initiatives include

strengthening the clinical focus of educator preparation programs, requiring programs to demonstrate the impact of their programs on student learning, increasing empirical evidence about what works in teacher training, and addressing school needs such as recruiting and retaining talented teachers. These changes reflect the growing national focus on the quality of teacher training and its role in student learning.

Another critique is that education researchers have not reached consensus on what constitutes a high-quality educator preparation program.

Another critique of NCATE is that educators have not reached a consensus on what constitutes a high-quality educator preparation program (Kappler). For this reason, the factors evaluated by NCATE are not necessarily a reflection of consensus in the academic community. Research on the impact of teachers from universities with NCATE accreditation is mixed. Teachers from NCATE-approved programs tend to pass the Praxis II examinations at higher rates than teachers from non-NCATE programs, but others have found little difference between teachers who attended NCATE-accredited programs and those who did not (Ballou and Podgursky). The value of accreditation is that it forces educator preparation programs to frequently evaluate their programs based on factors that could be associated with the production of high-quality teachers.

In addition to accrediting institutions, NCATE uses evaluation data to produce a list of nationally recognized educator preparation programs. Some Kentucky programs are included in these rankings for special education, physical education, and education psychology, but no Kentucky educator preparation program is nationally recognized for mathematics education.

Admittance to Educator Preparation Programs

EPSB sets the minimum standards for student admission to educator preparation programs in 16 KAR 5:020.

Each educator preparation program across the state has unique requirements for admission; however, EPSB sets minimum admission standards in 16 KAR 5:020. Students applying for admission to an educator preparation program are analyzed in terms of academic proficiency and candidate disposition.

Students who lack the requisite grades or grade point averages can demonstrate academic aptitude in multiple ways to gain admission to an educator preparation program.

Most educator preparation programs require applicants to possess a certain number of college credit hours; a college grade point average (GPA) of 2.5 or higher; and minimum scores on an entry exam, like the Praxis I or the ACT, to gain admission to their programs. Students who fail to meet entrance requirements can gain admission in other ways. For instance, a student with a low ACT score might be admitted to an educator preparation program if his or her college GPA is 3.0. Education programs also permit

students to take additional tests or remedial course work to demonstrate their potential to succeed in a teacher training program.

After being accepted into a program, students are required to maintain a minimum grade point average, typically 2.5.

After being accepted into a teacher preparation program, students are required to maintain a minimum GPA in their major, typically 2.5. The minimum GPA requirement acts as a measure of quality control, eliminating poorly performing students from the future teaching pool. However, with remediation or assistance, a student may be able to correct issues and reenter a program.

Education Professional Standards Board Mathematics Task Force

EPSB convened the Mathematics Task Force to review concerns over mathematics instruction among elementary teachers. Most notably, EPSB has approved a mathematics endorsement for elementary teachers.

EPSB is aware that mathematics requirements in educator preparation programs could be more rigorous and has made efforts over the last 5 years to improve the quality of mathematics teacher instruction. In light of research raising concern over mathematics teaching and learning, especially over the rigor and depth of mathematics content required for elementary certification, EPSB convened a Mathematics Task Force to review the issue. EPSB approved the task force recommendations and a time line for implementation in November 2008 (Commonwealth. Education. Mathematics). These recommendations in Table 3.3, along with others from a certification task force, directly address some of the quality concerns noted in research.

Table 3.3
Education Professional Standards Board
Mathematics Task Force Recommendations

	Recommendation	Time Line
I	Develop an endorsement certificate for mathematics. Endorsement to be in regulation.	Regulation in process
II	<p>Educator preparation programs should adopt a three-pronged approach to preparing elementary teachers to teach mathematics, focusing on content knowledge, pedagogical content knowledge, and verticality of P-12 mathematics curriculum. All educator preparation institutions with an approved elementary program should address</p> <ul style="list-style-type: none"> • deepening teachers’ knowledge of mathematics; • promoting mathematical reasoning, sense making, problem solving, computational fluency, and justification; and • ensuring that the Program of Studies and the core content for assessment are covered by courses. <p>Educator preparation programs should ensure that candidates</p> <ul style="list-style-type: none"> • learn how children learn mathematics so that teachers can use different texts and design instruction to meet individual learning needs. • learn how to determine what students know and understand, using formative assessments to guide instruction. • learn how to provide strategies and resources for differentiated mathematics instruction. <p>Educator preparation programs should fully address the topics on whole numbers, fractions, and the appropriate geometry and measurement topics in the critical foundations of algebra among elementary and middle school teachers.</p>	Due March 31, 2009; review in process
III	Colleges/universities should identify where in their mathematics courses/program components of mathematical content knowledge, pedagogical content knowledge, and verticality of curriculum are emphasized.	Due March 31, 2009; Review in process
IV	As curricula change, educator preparation programs and school districts should collaborate in codesigning mathematics courses.	Ongoing
V	Provide opportunities for pre-K-12 teachers to collaborate and discuss the challenges and issues of teaching mathematics across grade levels, and communicate the outcome of such discussions to administrators.	Ongoing

Source: Commonwealth. Education. Mathematics Task Force.

These recommendations cover issues of content, curriculum, and pedagogy, with specific reporting and documentation requirements for universities to support efforts to meet the mandates. The integration should also ensure that middle school mathematics is aligned with high school preparation. In addition, the new program requirements will be critically assessed when current programs are resubmitted for accreditation in the future.

Mathematics Requirements for Education Majors

Elementary Education Majors

Educators continue to debate the amount of mathematics content knowledge required of elementary teachers.

There is ongoing debate among education researchers about how much mathematics content knowledge an elementary teacher needs to know. Some believe that the general mathematics skills of most K-5 teachers are too low to adequately prepare young students for the types of complex mathematics they will encounter in middle school (Wu). The National Council on Teacher Quality (NCTQ) recommends that elementary teachers demonstrate knowledge of mathematics competency through Algebra II, and recommends a minimum of three mathematics content knowledge classes and one mathematics pedagogy class for elementary education majors. Other researchers claim that elementary teachers need deeper understanding of content knowledge pedagogy in order to explain core mathematical concepts to students (Bush).

Most educator preparation programs in Kentucky require two or three mathematics courses for elementary education majors. In general, two of the three courses are in mathematics pedagogy. Most programs do not require college algebra.

The mathematics requirements for elementary education majors at Kentucky colleges and universities vary. Most programs require two to three courses that include a combination of content knowledge and pedagogy. However, few programs require elementary education majors to complete any mathematics content beyond general education requirements. Kentucky Wesleyan, Union College, the University of the Cumberlands, the University of Louisville, Eastern Kentucky University, Murray State University, and Northern Kentucky University offer an elementary education mathematics emphasis. The mathematics emphasis usually requires a combination of mathematics content knowledge courses and pedagogy courses, including college algebra and geometry, not typically taken by elementary education majors.

The EPSB Mathematics Task Force recognized the need to increase mathematics performance among elementary education majors and advocated on behalf of creating an endorsement. Both Eastern Kentucky University and Western Kentucky University increased the mathematics requirements for elementary education majors in the last 2 years. Mathematics requirements for elementary education majors by educator preparation program are included in Appendix B.

National Council on Teacher Quality Report on Elementary Mathematics

The National Council on Teacher Quality has concluded that elementary education programs are weak in mathematics content requirements. It recommends that all elementary teachers be required to take college-level Algebra II.

The National Council on Teacher Quality has analyzed preparation programs for mathematics educators. The study found that few programs provide elementary teachers the mathematics content they need, and most programs are especially weak in algebra. The report pointed out that program accreditation by organizations like NCATE lacks specificity, thus educator preparation programs within a state can offer dramatically different mathematics curricula and requirements. The NCTQ report also concluded that the Praxis II examination in elementary education is an inappropriate tool to measure mathematics competency, and that the content of elementary mathematics courses is easy and student expectations are low (*No Common* 23-51).

NCTQ recommends that elementary educator preparation programs set acceptable thresholds for standardized achievement tests, college placement tests, and high school exit tests to ensure that all elementary educators have a strong grasp of high school geometry and second-year high school algebra. NCTQ advocates on behalf of requiring all elementary education teachers to pass a stand-alone elementary mathematics examination prior to certification. Massachusetts has developed this type of test, and nearly 75 percent of elementary school teacher candidates failed the new mathematics section of the state's licensing examination in 2009 (Vaznis).

Mathematics researchers have found that US elementary teachers need a profound understanding of mathematics that includes the ability to explain logic and proofs.

A feature of highly respected elementary education programs is a focus on mathematics pedagogy and content knowledge. Elementary education teachers do not need to know advanced calculus and trigonometry, but they do need to know how to teach basic algebraic concepts in multiple ways. A study that compared elementary mathematics teachers in China to elementary mathematics teachers in the US found that US mathematics teachers lacked the profound understanding of mathematics that Chinese teachers possess (Ma). That study found that most teachers in the US can solve elementary mathematics problems, but many lack a deep understanding of mathematical logic and proofs required to explain why something is true. Without this knowledge, many US teachers are ill-equipped to teach fundamental mathematics concepts to students (Milgram).

Middle School Mathematics Majors

The median number of mathematics courses required for middle school mathematics majors in Kentucky educator preparation program is eight.

Staff reviewed educator program requirements for middle school mathematics degrees and found that they were more challenging than the requirements for elementary education majors. On average, middle school mathematics programs require eight mathematics-focused courses, including advanced mathematics course work beyond basic algebra and a mix of pedagogical content knowledge courses. The types of mathematics courses required typically include college-level algebra, geometry, and calculus. However, some colleges allow middle school mathematics specialists to count courses such as Mathematics for Elementary Teachers toward the satisfaction of middle school mathematics degree requirements.

Kentucky and national data show that mathematics assessment scores decline as students transition from elementary to middle school to high school. Research on this subject suggests various reasons for the decline, attributing it to the onset of puberty, a less nurturing environment at middle schools, and student inability to comprehend the more complex material encountered in middle school mathematics.

International comparisons of mathematics educator preparation programs have found that US middle school teachers take fewer mathematics courses than their peers in some other countries.

An international comparison of mathematics educator preparation programs in six countries found that future middle school teachers in the US take fewer mathematics courses than do their counterparts in Taiwan, South Korea, and Bulgaria. In the algebra and analysis courses that provide the foundations for middle school algebra, future teachers in those countries covered about 80 percent of what the researchers deemed necessary content. Future middle school mathematics teachers in the US covered 56 percent of the necessary content (Schmidt et al.).

Secondary School Mathematics Majors

Beginning in 2012, all high school graduates in Kentucky will be required to complete 4 years of mathematics, including Algebra II.

Beginning in 2012, Kentucky will require all high school graduates to complete 4 years of mathematics that includes Algebra I, Geometry, and Algebra II. The greater emphasis on mathematics likely will exacerbate the shortage of mathematics teachers. In addition, the new curriculum will challenge Kentucky mathematics teachers to deliver high-level content to all students. This will require a strong focus on professional development for mathematics teachers who need additional training in pedagogical content knowledge.

As noted by EPSB’s Mathematics Task Force, it is important that the K-12 mathematics curriculum is vertically aligned. This means that teachers must understand how mathematics content and concepts build on and are interwoven with one another. While the task force review considered only elementary mathematics, this idea is relevant to both middle and high school, where course work taken by the student is cumulative and dependent on previous knowledge.

A typical high school mathematics educator preparation program requires 12 courses of mathematics content. This is almost the equivalent number of classes required of a mathematics major.

A typical secondary mathematics educator preparation program in Kentucky requires 12 courses of mathematics content. Most educator preparation programs require calculus, linear algebra, and discrete equations. Physics and information technology are often taken as electives. Table 3.4 shows the required mathematics courses for education majors seeking certification in secondary mathematics at eight public universities in Kentucky. In most cases, secondary mathematics certification almost matches the requirements for a full mathematics major. These patterns also hold for private, independent colleges in the state.

Table 3.4
Degree Course Requirements by Major at Public Universities in Kentucky, 2009

University	Total Courses	
	Secondary Math	Math Major
University A	10-12	14
University B	10-12	12
University C	12	13
University D	12	15
University E	12	14
University F	10-12*	17
University G	12	13
University H	12	12

Note: *Total courses required vary depending on an incoming student’s ACT score.

Source: Staff compilation of data from university course catalogues.

Special Education

Special education teachers deliver mathematics content to their students. They often collaborate with mathematics teachers but sometimes teach mathematics in self-contained classrooms.

Special education teachers are responsible for delivering mathematics content to their students, and these students are assessed and held accountable on the high mathematics standards established for all students. In many cases, special education teachers collaborate with mathematics teachers to teach mathematics. In these situations, the mathematics teacher and the special education teacher should plan the instruction together so

that the needs of special education students are met. In other situations, the special education students are taught in self-contained classrooms by special education teachers. In both cases, special education teachers must have knowledge of mathematics content and pedagogy sufficient to meet student needs.

Special education has consistently been an area of teacher shortage in Kentucky. Over 7,500 special education teachers have been granted emergency certificates or temporary provisional certificates since the 2001 school year.

For the last 10 years, special education has consistently been an area of teacher shortage in Kentucky. In fact, more special education teachers have received emergency certification than have mathematics teachers during this decade. Table 3.5 shows that 3,135 special education teachers received emergency certifications from the 2001 school year through the 2009 school year. During that same period, 4,492 special education teachers were granted temporary provisional certificates through Option 6, the university alternative. Teachers certified under this option can teach special education students from preschool through grade 12. The mathematics content knowledge needed to meet the needs of this wide range of students, especially at the upper grade levels, could be substantial.

Table 3.5
Emergency Certifications and Option 6 Certificates
in Special Education, 2000-2009

School Year	Emergency Certifications*	Option 6*
2001	592	6
2002	716	40
2003	686	183
2004	388	358
2005	292	453
2006	199	952
2007	121	992
2008	80	839
2009	61	669
Total	3,135	4,492

Note: *Emergency certifications in learning and behavioral disorders.
Source: Commonwealth. Education. Educator.

The mathematics requirements for special education teachers at educator preparation programs are minimal. In many master's programs, special education certification requires one mathematics pedagogy class.

The mathematics requirements for special education teachers at Kentucky educator preparation programs are minimal. In most graduate programs, special education majors are required to take one methods course in teaching mathematics to students with learning disabilities. Despite these limited content requirements, these teachers are expected to have their students performing on par with regular education students.

Recommendation 3.2

Recommendation 3.2 is that EPSB and KDE form a joint special education task force to address the specific needs and challenges of teaching mathematics to special education students.

The Education Professional Standards Board and the Kentucky Department of Education should form a joint task force to address the specific needs and challenges of teaching mathematics to special education students. This analysis should include a review of current literature and best practices on the instruction of mathematics to special education students and a review of the mathematics course work requirements of special education teacher training programs and master's programs in Kentucky. Findings and recommendations should be presented to the Education Assessment and Accountability Review Subcommittee by June 30, 2011.

Problems Affecting Educator Preparation Programs

After EPSB approves an educator preparation program, it is the responsibility of the program to provide a complete education to all students. However, compliance with EPSB mandates varies widely. Each program selects the students who are admitted, the instructors who teach the students, the subject matter covered, and the specific graduation requirements. This variation creates programmatic differences that can impact the quality of undergraduate instruction.

The consistency of mathematics content required for preservice middle school teachers has been found to vary across the state. This means that the content of Algebra I taught at one university is different from the content taught in Algebra I at another university.

Curriculum Differences. The materials and depth of content vary across institutions—even within an institution. A team of mathematics specialists from the University of Louisville analyzed the consistency of mathematics content required for preservice middle school teachers in six educator preparation programs in Kentucky. The study analyzed the breadth of knowledge that preservice middle school mathematics teachers learn in their courses. The methodology used findings from national and international studies to prioritize content in the subdomains of numbers and computation, geometry and measurement, probability and statistics, and algebraic concepts (Moody).

University of Louisville researchers found wide variation in the priority content covered by mathematics courses for middle school teachers at six Kentucky universities.

That study found that the percentage of high-priority mathematics content in subjects such as algebra and calculus varied from university to university. One course covered 94 percent of high-priority content in algebra, while another covered 26 percent. The study also found significant variation in the amount of high- and low-priority numbers covered in each subdomain. One conclusion of the study is that mathematics educators at educator preparation programs should come together to discuss priority content and

revise courses and curricula to ensure more consistent instruction across the state (Moody 8).

Variation in the instructional content presented and tested, especially high-priority content, may produce teacher candidates from some universities who are underprepared in key curriculum areas. EPSB's Mathematics Task Force recommendation that would require educator preparation programs and school districts to collaborate in codesigning courses when standards and curriculum changes are made in compliance with Senate Bill 1 could provide needed standardization of course content. The new standards being developed will require such collaboration at the elementary level, and programs should be required to carry out this same collaboration across all educator preparation programs.

Recommendation 3.3

Recommendation 3.3 is that EPSB and KDE collaborate with the Kentucky Committee for Mathematics Achievement to study the alignment of mathematics content knowledge and pedagogy courses at educator preparation and master's programs to determine if important mathematics content and research-based teaching skills are provided sufficiently.

The Education Professional Standards Board and the Kentucky Department of Education, in collaboration with the Kentucky Committee for Mathematics Achievement, should study the alignment of mathematics content knowledge and pedagogy courses at educator preparation and master's programs to determine if important mathematics content knowledge and research-based teaching skills are provided sufficiently in relevant courses. The findings should address concerns regarding the content and pedagogical preparation of mathematics teachers at both the undergraduate and graduate program levels and should offer recommendations to the Education Professional Standards Board on how programs and program evaluations can be improved. The findings and recommendations should be reported to the Education Assessment and Accountability Review Subcommittee by June 30, 2011.

Staffing and Capacity Differences. It appears that the number of education and mathematics faculty at Kentucky's public universities is adequate to offer sufficient courses and to enroll current education major applicants. The University of Kentucky's College of Education faculty includes four professors within its secondary mathematics program, seven faculty members from scientific disciplines, and four mathematics teachers active in local public schools. The University of Louisville's College of Education and Human Development houses the Center for Research in Mathematics and Science Teacher Development that has 10 faculty members. Northern Kentucky University is the home of the Kentucky Center for Mathematics, which was

established in 2006 (KRS 164.525). The accreditation process evaluates unit governance and resources; all programs in Kentucky, with the exception of one, meet accreditation thresholds on this criterion.

Staff analysis of educator preparation program faculty found differences in the number of mathematics specialists per program. Mathematics specialists are important resources for teaching pedagogical content knowledge courses.

However, one potential indicator of an educator preparation program's quality is the number of faculty who hold a doctorate. In mathematics pedagogy, the supply of mathematics education specialists with doctorates is low (Bush). Mathematics specialists possess both mathematics content knowledge and mathematics pedagogical content knowledge. This is important because classroom mathematics teachers require advanced pedagogical skills to move students beyond rote memorization of formulas to a deep understanding of why formulas work. The depth of pedagogical knowledge needed to teach advanced mathematical thinking to students is not always present in the general mathematics departments; therefore, educator preparation programs need doctoral-level mathematics specialists with deep content knowledge and pedagogical skills.

Staff analysis of faculty composition at colleges and universities in Kentucky confirms that many educator preparation faculties do not include significant numbers of mathematics specialists. In some cases, education majors are dependent on the mathematics faculty for both mathematics pedagogy and content knowledge courses. This does not mean that education majors at these universities are getting a low-quality mathematics education. However, the distribution of mathematics specialists could partially explain the discrepancies in mathematics content discovered by the team of University of Louisville researchers discussed earlier.

In general, the capacity of educator preparation programs across the state to deliver a full elementary, middle, and high school mathematics curriculum varies.

In general, the capacity of education departments across the state to deliver a full elementary, middle, and high school mathematics curriculum varies. The accreditation process requires educator preparation programs to analyze faculty qualifications, performance, and development. Typically, programs report data on all full-time education faculty and full-time faculty from other departments who contribute in significant ways to educator preparation programs. For example, the University of Kentucky reports the percentage of its professional education faculty with earned doctorates as proof of its faculty qualifications. Performance is gauged by evaluating faculty teaching portfolios, teacher candidate evaluations of courses and instructors, teacher awards and professional recognition, number of published articles, dollar value of external grants, number of collaborative and service

activities of faculty, and annual personnel reviews. All these measures can be used to develop a portrait of faculty quality.

The capacity of an educator preparation program to deliver high-quality teacher training will become even more critical when EPSB implements its master's redesign program and the new regulation for an elementary mathematics endorsement. It will be important for future EPSB program reviews and approvals to consider the capacity of the school to offer the breadth and depth of programs and pedagogical training necessary to meet the needs of classroom teachers.

Recommendation 3.4

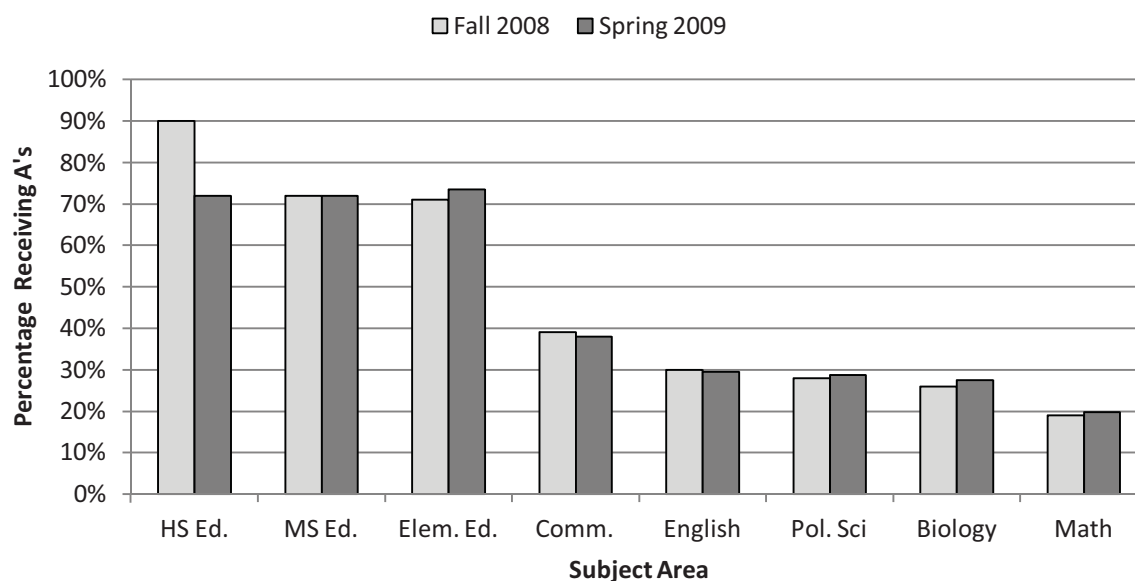
Recommendation 3.4 is that EPSB establish procedures for requests to implement elementary mathematics endorsement programs.

The Education Professional Standards Board should establish rigorous review and approval procedures for institution requests to implement elementary mathematics endorsement programs by requiring proof of program capacity to provide the level of instruction required, which includes having sufficient mathematics specialists on staff.

Grade distribution data suggest that students who take courses in education receive higher grades than students in other disciplines. Additional research is needed to better understand the factors associated with this discrepancy.

Mathematics Performance. Critics of educator preparation programs claim that education programs are easy majors that attract students seeking limited mathematics requirements (Levine). To analyze the merits of this argument, OEA staff reviewed grades for various academic programs at the University of Kentucky. Figure 3.A shows the distribution of A grades by different academic departments during the 2008 academic year. The data show that mathematics performance for most college students is low, with 20 percent or less of the courses in mathematics resulting in a grade of A. In contrast, 70 percent or more of students taking classes in elementary education, middle school education, and secondary education received A's. These data do not control for the student's major; therefore, it is impossible to tell whether education majors taking mathematics courses have high or low grades in that subject.

Figure 3.A
University of Kentucky Grade Distributions, 2008



Source: University of Kentucky.

The same data for other Kentucky universities are not available, but similar patterns have been found in research conducted at universities across many states. For example, more than 50 percent of education majors at Penn State University made the Dean’s List in 2004, where the average education GPA rose from 3.08 in 1994 to 3.39 in 2004. At the University of Wisconsin-Madison, 58 percent of education majors received A’s in the spring 2008 semester, compared to 38 percent of English majors, 26 percent of geography majors, 23 percent of mathematics majors, and 21 percent of political science majors. Grade distribution data from Indiana University in the last 3 years show similar grade patterns and an exceptionally high number of A’s given in education courses.

The grade distribution data suggest that a qualitative difference exists between education and noneducation classes in terms of student performance.

The grade distribution data suggest that a qualitative difference exists between education and noneducation classes in terms of student performance. Additional research is needed to determine the rigor of education course work and majors in Kentucky.

Master’s Degrees

After receiving certification, teachers must satisfy continuing education and professional development requirements. Continuing education usually means completion of a master of arts in education that leads to Rank II and higher pay.

KRS 161.1211 outlines ways to meet the rank change requirements. Kentucky boasts one of the nation's highest rankings for highly educated instructors because of this mandate. This section focuses on continuing education requirements for in-service teachers and approved education graduate programs in Kentucky. Programmatic redesign of the master's programs as mandated by EPSB is outlined in this section, along with relevant research on the value of master's degrees on teaching quality. In the concluding section of this chapter, best practices in graduate education for teachers are presented.

Admission to Education Master's Programs in Kentucky

There are 16 educator preparation programs that offer master's degrees for teachers in Kentucky. Some programs have online components or meet at satellite campuses to serve all teachers.

Teachers in Kentucky can fulfill rank change requirements by enrolling in one of 16 EPSB-approved master's programs offered across the state. Several master's degrees are offered through satellite campuses situated to improve access to teachers who do not live near a university. In addition, some programs offer online and weekend courses to facilitate student access to courses.

Applicants to graduate programs have to meet minimum admission requirements. Entry requirements to graduate programs in teacher education vary, yet most require a minimum undergraduate GPA of 2.5 to 2.75, letters of recommendation, and in some cases Graduate Record Examination (GRE) scores. Several schools do not set a minimum GRE score. Some programs provide unconditional admission to students with an undergraduate GPA of 3.0 or higher. If applicants lack the minimum GPA, other factors such as higher exam scores can be used to allow admission. Program descriptions point out that several variables are considered when making admission decisions. In cases where the applicants' GPA and GRE scores are not acceptable, universities can grant conditional admission to programs, requiring students to prove themselves in the program by achieving high grades during two probationary semesters.

Entrance requirements for master of arts in education programs are not particularly high. Because all teachers are required to fulfill continuing education requirements, admission to most programs is not problematic.

Because Kentucky teachers are required to obtain a master's degree, typically a master of arts in education, graduate programs do not impose high entrance requirements that would result in denying admission to graduate school. Educator preparation programs are obligated to meet the continuing education needs of Kentucky teachers. The average undergraduate GPA for education majors tends to be much higher than the 2.75 threshold used to screen candidates by many master of arts in education programs in Kentucky. Additionally, applicants unable to meet minimum examination or GPA requirements can often gain admission in

other ways, for instance, by submitting passing Praxis II scores. In these cases, teacher certification is the standard for admission to a master’s program.

Mathematics Content Knowledge in Master of Arts Programs

Practicing teachers who apply for graduate school have already passed the Praxis II content knowledge examination and undergraduate degree requirements. Graduate programs in education tend to focus on curriculum, learning and development, research methods, and classroom instruction. However, core course requirements vary from program to program. Table 3.6 includes a sample of required course work for master of arts in education programs from different universities. In general, the elementary programs require fewer mathematics content knowledge courses than middle and secondary programs. Several of the master’s programs for secondary mathematics teachers mandate two to four courses of content knowledge.

Table 3.6
Sample Core Course Work at Kentucky
Master of Arts in Education Programs, 2009

Sample Masters of Arts in Education Curriculum		
Elementary School	Middle School	Secondary School
Research Methods	The Middle School	Secondary School Curriculum
Advanced Child Development	Research Methods	Research Methods
Elementary School Curriculum	Social and Ethical Development of Teaching	Advanced Human Growth and Development
Advanced Curriculum and Methods	Developing Cross Cultural Competence	Effective Classroom Instruction
Diagnosis of Reading Difficulties	Advanced Human Behavior, Development, and Learning	Secondary School Curriculum
History and Philosophy of Education	Instructional Design and Curriculum	Measurement Principles and Techniques
Technology Across the Curriculum	Area of Interest Capstone Course	Secondary Mathematics
Parents, Schools, and Community	6 Hours in Content Area	12 Hours of Mathematics, Statistics, or Computer Science

Source: Staff compilation of university graduate program requirements.

Course Taking in Master of Arts in Education Programs

OEA staff reviewed transcripts of 49 recent master of arts in education recipients. The transcripts came from more than 15 universities within and outside Kentucky.

The transcript review showed that 32 percent of mathematics teachers receiving master's degrees took no mathematics content or mathematics pedagogy classes.

Many teachers took administrative courses that were not directly related to teaching mathematics.

EPSB provided OEA staff with 49 randomly selected graduate school transcripts of certified mathematics teachers who recently completed a master of arts in education. All information regarding the identity of the graduate student was eliminated. The transcripts covered 15 universities in Kentucky and elsewhere. The programs included large public universities, small private universities, and private online master's providers. The sample size is not large enough to make broad generalizations from the data, but it provides a snapshot of course-taking behavior.

Overall, 32 percent of the mathematics teachers receiving master's degrees took no mathematics content or pedagogy courses. Fifty-nine percent took one or no mathematics content classes, and 84 percent took one or no mathematics pedagogy classes. These results could reflect the fact that certified mathematics teachers already possess strong mathematics content knowledge and do not require mathematics-intensive instruction at the graduate level. About 10 percent of the sample—five student transcripts—reflected intensive courses in mathematics content. A total of 54 percent of the transcripts included a research methods course.

The transcript review also showed that many teachers who completed master's programs took several administrative courses not directly related to mathematics, potentially indicating their interest in becoming education administrators. However, completion of a master's leads directly to rank change and higher pay for the classroom teacher. The following are examples of courses taken by mathematics teachers in their master's programs:

- Workshop in elementary language arts—newspapers
- Education budgeting and finance
- School law for administrators
- Human resource development
- School business management
- Problems in education administration
- Theories of counseling
- School law
- School community relations
- Leisure and aging
- Sports psychology for coaches

The Value of Master's Degrees in Education

Some recent studies on the value of a master's degree in education have been critical of the focus of these programs. Critics believe that master's programs in education are not linked to higher levels of student achievement.

The value of a master's degree, as reflected by the impact of the teacher on student performance, is an issue that has been studied recently by several organizations and education researchers. Many of these studies conclude that master's degrees in education are not linked to higher student performance and that completion of a graduate degree adds little or no value to teacher quality (Roza and Miller; Gordon, Kane, and Staiger; Hanushek and Rivkin. "How to Improve"; Aaronson, Barrow, and Sander). The *New York Times* reported that the Director of Teacher Education at the Harvard Graduate School of Education said that only about 100 of the 1,300 graduate teacher training programs are doing a good job; "the others could be shut down tomorrow."

Researchers reviewed relevant literature on the value of master of arts in education degrees and concluded that advanced degrees do not make teachers more effective. There is some limited evidence that secondary mathematics teachers with master's degrees in mathematics perform marginally better than mathematics teachers without master's degrees. This finding did not hold for middle school or elementary teachers (Walsh and Tracy).

New Mexico evaluated its teacher licensure program and concluded that the student achievement gains associated with higher teacher rank were not significantly higher than the student gains associated with lower-ranked teachers

A study by the New Mexico Legislative Finance Committee evaluated the state's teacher licensure program. As in Kentucky, teacher pay in New Mexico is determined by years of experience and continuing education. Teacher completion of a master's degree leads to a rank change and higher salary. The study concluded that performance gains made by students of the teachers with the highest level of licensure were not significantly higher than the gains produced by students of teachers with lower licensure levels (State of New Mexico). As a result of the study, the New Mexico Public Education Department is considering a pilot program that would use teacher impact on student performance as a primary factor associated with pay increases.

The Education Professional Standards Board's Master of Arts Redesign

EPSB responded to the debate about master's degrees by redesigning degree requirements to focus on the Teacher Leader Master's Program.

EPSB reacted to the debate about education master's degrees by redesigning the format of master of arts in education programs. The goal of the redesign is to focus on leadership in the master's requirements for teachers. The redesign guidelines were approved by EPSB in 2007; 16 KAR 5:010(12) establishes the new Teacher Leader Master's Program. According to regulation, master's programs or Planned Fifth-Year programs for Rank II approved by

EPSB prior to May 31, 2008, must stop admitting new students after December 31, 2010. Those students admitted before December 31, 2010, will have until January 31, 2013, to finish their programs. All students admitted to master's programs leading to rank change after December 31, 2010, must complete the Teacher Leader Master's Program.

All master's programs in the state must submit redesign plans to EPSB's Master's Redesign Review Committee for approval.

Education programs across the state must submit redesign plans to the EPSB Master's Redesign Review Committee. The committee reviews the plans and works with the university to ensure compliance with the requirements. Ultimately, the committee can approve, approve with conditions, or deny approval. According to 16 KAR 5:010, each Teacher Leader Master's Program must detail and document the following requirements:

- The unit's plan to collaborate with school districts to design courses, professional development, and job-embedded professional experiences that involve teachers at the elementary, middle, and secondary levels
- The unit's collaboration plan with the institution's arts and science faculty to meet the candidate's academic and course accessibility needs
- The unit's process to individualize a program to meet the candidate's professional growth or improvement plan
- The unit's method to incorporate interpretation and analysis of annual P-12 student achievement data into the program
- The institution's plan to facilitate direct service to the collaborating school districts by education faculty members

The goal of the EPSB master's redesign is to add focus to teacher graduate education so that the programs will produce better-prepared and more effective classroom teachers.

The Teacher Leader Master's Program requirements incorporate many best practices suggested by critics of traditional master's teacher education programs. One central critique of traditional master's programs is that they are unfocused. One researcher pointed out that excellent graduate programs in education focus on the needs of classroom teachers, have strong curricular coherence and balance, and have high graduation and degree standards (Levine). EPSB believes that a focused master's program will yield better-prepared and more effective teachers.

The redesign calls for greater collaboration between educator preparation program faculty and school districts. By engaging in applied service, professors will gain more insights into the classroom challenges faced by K-12 teachers.

The Teacher Leader Master's Program requires collaboration with school districts and university faculty to provide content knowledge courses in mathematics and statistics. Also, the new programs will focus on strengthening a teacher by tailoring courses to meet each teacher's unique needs. Finally, each program must facilitate direct service to the collaborating school district by education faculty. This addresses the potential disconnect between higher education and K-12 education. Educator preparation

programs and their faculty are encouraged to engage in more applied service and, in the process, gain a better understanding of the classroom challenges that teachers face.

The curriculum delivered in the newly designed Teacher Leader Master's Program will also change. The regulation calls for curriculum redesign that prepares candidates to

- be leaders in their schools and districts;
- evaluate high-quality research on student learning and college readiness;
- deliver differentiated instruction for P-12 students based on continuous assessment of student learning and classroom management;
- gain expertise in content knowledge, as applicable;
- incorporate reflections that inform best practices in preparing P-12 students for postsecondary opportunities;
- support P-12 student achievement in diverse settings;
- enhance instructional design using the Program of Studies, Core Content for Assessment, and college-readiness standards;
- provide evidence of candidate mastery of Kentucky Teacher Standards using advanced-level performances and Specialized Professional Associations standards if applicable; and
- design and conduct professionally relevant research projects (16 KAR 5:010).

As the state undergoes major K-12 standards and curriculum changes mandated by Senate Bill 1, each Teacher Leader Master's Program will have to ensure that the content knowledge matches Kentucky's new standards and core content. The success of this is contingent on training teachers to deliver differentiated instruction based on continuous student assessment. Given different student learning styles, a teacher must be able to tailor teaching to meet multiple needs of visual, auditory, or hands-on learners.

All the features of the redesigned Teacher Leader Master's Program address concerns over the value of the current master's program. The requirements are intended to establish program rigor; they focus on individual teacher needs and the needs of the school, a focus that is currently lacking in master's programs.

Three Teacher Leader Master's Programs have been submitted and approved. The remaining programs must be approved before January 1, 2011, when the program is mandatory.

The success of this initiative lies in its implementation. The EPSCB committee responsible for review and approval of Teacher Leader Master's Programs must be given sufficient authority to critically address weaknesses in proposed programs and the ability to disapprove or approve those programs that do not meet the requirements. As of this writing, proposals from three institutions

have been accepted by the Master's Redesign Review Committee, and the programs began training students in August 2009. The remaining programs must have their plans submitted for approval before January 1, 2011, when the program is mandatory.

The success of the initiative needs to be demonstrated through rigorous evaluation.

Finally, after programs are approved and operational, the success of this initiative must be monitored and evaluated through collection and review of data. Rigorous program evaluation by EPSB will require preprogram and postprogram measures of teacher performance. A program evaluation methodology must be designed that can measure the impact that graduates of the Teacher Leader Master's Program have on student achievement in the classroom.

Recommendation 3.5

Recommendation 3.5 is that EPSB develop a program evaluation methodology and time line for measuring the impact of the Teacher Leader Master's Program by June 30, 2011.

The Education Professional Standards Board should develop program evaluation methodology and a time line for measuring the impact of the Teacher Leader Master's Program by June 30, 2011. The methodology should include data that permit detailed analysis at a content and program level.

Professional Development

Another element of teacher training that is widely considered to be a critical component of teacher quality is professional development. As noted by the National Commission on Teaching and America's Future, the success of all educational reforms rests on the knowledge and skills of classroom teachers; as learning standards, assessments, and student populations evolve, so must teachers' professional learning opportunities.

While most education researchers agree that teacher professional development is related to student performance, the linkages are difficult to quantify.

Researchers have yet to produce a body of work establishing clear links between professional development and student achievement. This is due, in part, to the fact that professional development takes varied forms and is difficult to separate from the myriad factors that might influence student achievement in a given school or classroom (Noyce). Researchers have reached some consensus, however, on the characteristics of professional development that are most likely to influence teachers' beliefs, knowledge, skills, and classroom practices.

Some researchers have called for a change in the way that professional development is designed and delivered. Teachers need professional development that is ongoing, sustained, job embedded, and collaborative.

Numerous reports, including a 1997 evaluation of Kentucky's professional development program, have called for change in the way that professional development is designed and delivered (McDiarmid et al.). These reports point out the shortfalls of one-day workshops or conferences that are most frequently associated with teacher professional development. Instead, professional development should include research-based practices such as sustained, job-embedded, and collaborative opportunities for teachers to examine and improve their teaching. These opportunities should include work with external experts and school colleagues. For mathematics and science teachers, in particular, both content and pedagogy should be addressed. Research also stresses the important role of local leadership in supporting and sustaining improvements through professional development (Weiss; Blank).

Statutes and Regulations

In Kentucky, teachers are required to receive 4 days of professional development. One of those days may be used to support districtwide programming at the discretion of the superintendent.

KRS 158.070 requires that 4 days of the calendar year be used to provide professional development for professional staff. One of the 4 days may be used to support districtwide programming at the discretion of the superintendent. The other 3 days are planned by school-based decision making councils. Local boards may also approve flexible professional development programs that allow staff to count professional development attended outside the regular calendar year toward the required 24 hours of professional development.

“Professional development” is defined by 704 KAR 3:035(2) as:
those experiences which systematically over a sustained period of time, enable educators to acquire and apply knowledge, understanding, skills, and abilities to achieve personal, professional, and organizational goals and to facilitate the learning of students.

The regulation requires districts to develop professional development plans that are implemented and evaluated by a district professional development coordinator. These plans should align with district and school goals as well as with teachers' individual growth plans. Upon request by school councils, district professional development coordinators can also assist with professional development needs assessments and can advise school councils about available professional development opportunities.

Districts are responsible for developing and evaluating professional development plans, for approving professional development requests, and for keeping track of professional development received by staff.

As described in regulation and statute, professional development primarily is a local-level function in Kentucky. Districts are responsible for developing and evaluating professional development plans, for approving professional development requested by schools, and for keeping records regarding professional development received by staff.

Chapter 4

Teacher Quality Indicators

Introduction

Public schools are under state and federal mandates to minimize student achievement gaps and prepare all students for advanced learning and the workforce. The most critical variable affecting the student—the teacher—is frequently overlooked.

Public schools are under state and federal mandates to minimize student achievement gaps and prepare all students for advanced learning and the workforce. States have worked to improve student learning by investing heavily in new classroom technology, cutting-edge learning programs, complex student assessment rubrics, and an array of student support services. However, the most critical variable affecting the student—the teacher—is frequently overlooked. The teacher is the conduit for transferring complex knowledge into meaningful and useful tools for continuing education to students. Ultimately, the success of any new educational strategy is dependent on the human capital that is responsible for implementing any education reform or initiative. One report concluded that “the quality of an education system cannot exceed the quality of its teachers” (McKinsey 13).

This chapter reviews attributes such as experience, certification, and graduate education, and the role of content knowledge in teacher quality.

This chapter analyzes indicators of teacher quality commonly associated with teacher knowledge and ability. The review covers teacher experience, teacher certification, master’s degrees, and content knowledge. Kentucky data, when available, are presented for each attribute. This chapter also reviews three current indicators of quality recognized in Kentucky: national board certification, pay rank, and years of experience. This chapter also reviews the literature on the value of pedagogical content knowledge and content knowledge.

Assumptions are frequently made about the value of certain teacher attributes, yet the literature suggests that most of the commonly considered attributes have minor if any impacts on student performance. However, the framework for teacher compensation in many states, including Kentucky, is based on the assumption that teacher experience and continuing education produce teachers who yield high student performance. Research indicates that common teacher quality indicators might reflect aptitude and demonstrate past success in scholastic environments, but they do not necessarily predict the ability to teach.

Teacher Quality Indicators Tied to Compensation in Kentucky

Teacher Rank

Teacher compensation in Kentucky is tied to years of experience and educational attainment. New teachers typically are hired at Rank III. After completing a master's degree or other continuing education, teachers move to Rank II. Additional education is required to attain Rank I.

In Kentucky, teacher compensation is based on a single salary schedule at each district, where movement up the scale is tied to years of experience and educational attainment as set out in KRS 161.1211. Each teacher fits into the salary schedule at a pay rank. New teachers with bachelor's degrees and teaching certificates are hired at Rank III. After completion of a master's degree, a Planned Fifth-Year program, or an approved program of continuing education credits, teachers can achieve Rank II. Teachers move to Rank I by finishing additional requirements that are the equivalent of about 10 graduate-level courses or through attaining national board certification. Teachers who are working on emergency certification are considered Rank IV and generally make up less than 1 percent of all mathematics teachers. Table 4.1 lists the percentage of teachers in Kentucky by rank.

Table 4.1
Percentage of Teachers by Rank, 2009

Rank	All Teachers	Middle School Mathematics	Secondary Mathematics
Rank I	25%	25%	30%
Rank II	50%	48%	47%
Rank III	24%	26%	22%

Note: Less than 1 percent of teachers in Kentucky are Rank IV—emergency certified.

Source: Staff compilation of Kentucky Department of Education professional staffing data, 2008.

Research suggests that neither teacher experience nor educational attainment is strongly linked to student performance.

Research indicates that neither years of experience nor educational attainment is strongly linked to student performance. At the secondary level, a master's degree in content knowledge has been linked to student achievement gains.

New Mexico studied its compensation system and found that the minor student achievement gains produced by more experienced, higher-ranked teachers did not merit the extra costs associated with high rank.

Similar to Kentucky, New Mexico has a system of pay tied to rank. New Mexico studied the issue of student performance and found that the minor student achievement gains produced by higher-ranked teachers did not merit the extra costs associated with high rank (State of New Mexico).

Master's Degrees

Teachers are required to receive their master's degrees within 10 years of becoming certified. Over 70 percent of Kentucky teachers have master's degrees. Research on the value of education master's degrees in producing student achievement gains is inconclusive.

Teachers in Kentucky are required to receive their master's degrees within 10 years of becoming certified. Because of this requirement, more than 70 percent of teachers in Kentucky have master's degrees. Completion of the master's degree leads to Rank II and higher compensation. However, research on the value of master's degrees and teacher effectiveness is inconclusive.

In the 2007 school year, 605,000 master's degrees were conferred in the United States; 26 percent of those were in education, and less than 1 percent were in mathematics and statistics (Planty). Several studies have concluded that teachers with master's degrees are not more effective in the classroom than teachers without master's degrees (National Council. *Tackling*; Aos). Research on the positive impacts of certification on teacher quality is too thin to justify major policy decisions in support of traditional certification (Boyd). Mathematics education, especially at the secondary level, is an exception. Mathematics teachers with master's degrees in mathematics, not education, are associated with higher secondary student performance in mathematics (Walsh and Tracy).

In Kentucky, the costs associated with master's degrees are substantial. Table 4.2 shows the estimated financial costs of master's degrees for all teachers in Kentucky for school years 2005 through 2008. In 2008, the additional pay associated with teachers who held a master's degree was \$93 million. The same year, the annual cost for teacher rank changes associated with newly conferred master's degrees was more modest, at about \$7.4 million. Kentucky teachers are compensated millions of dollars per year for having master's degrees. For accountability purposes, the value of that investment should be analyzed.

Table 4.2
Financial Cost Estimates for Master's Degrees
School Years 2005-2008

Cost of Master's Degree	School year			
	2005	2006	2007	2008
All master's degree holders	\$83,047,922	\$87,047,922	\$91,596,719	\$93,000,374
New master's degree holders*	\$6,441,072	\$6,809,041	\$7,654,045	\$7,483,215

Note: * New master's degree holders are defined as those who moved from Rank III to Rank II on district salary tables.

Source: Staff compilation of Kentucky Department of Education professional staff data.

Many administrators and teachers interviewed by OEA staff questioned the value of their master's degrees in making them more effective teachers.

During OEA site visits, staff questioned teachers and administrators about the value of their master's degrees and master's degrees in general. The site visit data raise concerns about the relationship between master's degrees and mathematics teaching and learning.¹ The majority of teachers interviewed for this study acknowledged that graduate courses did little or nothing to improve the way they taught mathematics. Fewer than 10 of 75 teachers interviewed reported taking master's course work that was directly relevant to teaching mathematics. Teachers reported receiving master's degrees in programs such as administration that do not require mathematics or classroom-specific course work. Notable exceptions were teachers enrolled in a master's program designed for secondary mathematics teachers and teachers who had received degrees in counseling. Most of these teachers attributed some benefit to their classroom instruction as a result of master's courses.

Many teachers expressed interest in courses with mathematics-specific teaching methods and reported a lack of such courses at local postsecondary institutions. Several teachers described unsuccessful attempts to locate mathematics-relevant courses or to work with local postsecondary institutions to offer courses at accessible times, such as summers, nights, and weekends. A minority of mathematics teachers interviewed expressed interest in taking courses in advanced mathematics content, but most felt they already possessed content knowledge sufficient for teaching at their grade levels. Teachers also perceive master's courses in mathematics as much more challenging and time consuming than other types of master's courses.

Teachers who were interviewed cited cost and convenience as primary criteria in choosing among master's programs. Teachers mentioned that there are no financial incentives for them to increase mathematics content knowledge or pedagogy.

Teachers cited cost and convenience as primary criteria in choosing master's programs. Teachers also reported that master's degrees in subject matter that qualifies them for higher-paying jobs in administration drive their curricular choices. This held true even for teachers who had no immediate desire or intention to leave classroom teaching. In contrast, teachers reported no financial incentive to increase their knowledge of mathematics content or pedagogy. This lack of financial incentive may deter teachers from seeking out mathematics courses, especially if the courses are perceived to be difficult.

¹ The sample of teachers interviewed for this study is not necessarily representative of teachers across the state. Therefore, it is not possible to generalize concerns raised with these data to master's degrees received by teachers across the state.

National Board Certification

The National Board for Professional Teaching Standards provides continuing education to teachers who are accepted to the program. Within the teaching field, national board certification is a distinction.

The National Board for Professional Teaching Standards (NBPTS) is an independent, nonprofit organization that developed a set of standards it believes teachers should know and be able to meet. For teachers, NBPTS offers national board certification in 25 subject areas, including mathematics. National board certification is considered a distinction in most states. The program is competitive, and interested candidates must apply to NBPTS for acceptance into the program.

The application process is time intensive, requiring applicants to submit portfolios and essays focusing on content knowledge pedagogy. The portfolios and essays are used to determine entry into the national board certification program. Once accepted, the teacher must pay \$2,500 and participate in intensive training.

Research on the value of national board certification is inconclusive. Some studies have found that national board-certified teachers are associated with higher student achievement.

Research on the value of national board certification is inconclusive. Some research has found that mathematics teachers with national board certification are associated with slight gains in student mathematics scores (Goldhaber and Anthony; Cavaluzzo). However, other researchers found no statistically significant relationship between teacher national board certification and student mathematics performance (Sanders, Ashton, and Wright).

Kentucky teachers with national board certification receive pay supplements of \$2,000 per year for up to 10 years.

KRS 157.395 requires local districts to pay an annual salary supplement of \$2,000 to Kentucky teachers with national board certification. Teachers can receive the supplement for a 10-year period if they mentor or teach in their subject areas. In addition, national board certification can be used to achieve Rank I.

As of 2008, 129 mathematics teachers in Kentucky had received national board certification. The distribution of teachers with national board certification is skewed toward high-performing schools.

As of 2008, 1,648 teachers in Kentucky had achieved national board certification; 129 of them taught mathematics. In FY 2009, the General Assembly spent approximately \$2.7 million to reimburse districts for supplemental pay received by teachers with national board certification. Of these 129 mathematics teachers, in 2008, 4 were employed at the district level, 3 were in elementary schools, 41 were in middle schools, and 81 were in high schools. Staff analyzed the distribution of national board-certified mathematics teachers in the top and bottom 20 high schools in terms of 2009 average ACT mathematics performance: 14 worked in the 20 top-performing schools, and only 3 worked in the lowest-performing 20 high schools.

Teacher Experience

Teacher experience is a major variable in teacher compensation. However, research shows that teacher quality is not strongly correlated with years of experience.

One teacher attribute that is at the center of the teacher quality debate is experience. Education researchers have examined the relationship between teacher experience and student performance and found conflicting results. Many researchers agree that experienced teachers are more effective than non-experienced teachers. In general, novice teachers with less than 3 years of experience are less effective than teachers with more than 3 years of experience. New teachers experience a learning curve in their first years of teaching that contributes to lower student performance. The lower effectiveness of novice teachers is associated with learning classroom management skills and developing lesson plans. However, after a teacher has gained 3 years of experience, they are as effective as more veteran teachers in terms of producing student achievement gains (Harris; Gordon).

Novice teachers with fewer than 3 years of teaching experience have been found to be less effective than more-experienced teachers. However, after 3 years, the benefits of experience taper off.

Schools with high percentages of novice teachers have been linked to high achievement gaps in North Carolina schools (Clotfelter, Ladd, and Vigdor. "Teacher Sorting"). Similar studies have not been conducted in Kentucky, but staff analysis of novice teacher distribution in Kentucky schools did not find a correlation between mathematics teacher years of experience and school-level performance on the Kentucky Core Content Test in mathematics. However, this could be the result of a more or less even distribution of inexperienced mathematics teachers across the state. If this is the case, the impact of novice teachers would show up in the overall test results for the entire state.

A comprehensive study of teacher experience and student achievement would require a data system that permits individual teachers to be linked to individual students.

In Kentucky, experience is used to determine teacher pay. If a teacher's experience is not a strong predictor of teacher effectiveness and student achievement, reform of teacher compensation should be considered. A comprehensive study of the impact of teacher experience on student performance gains would require databases that link individual teachers with individual students. Without such a database, it is difficult to determine if teacher experience has an impact on student achievement. Kentucky is currently developing a P-20 database that may allow linkage of data to evaluate the role of teacher experience on student outcomes.

Other Teacher Quality Variables

Teacher Certification

An ongoing debate in the education research literature is the impact of teacher certification on student performance. Kentucky teachers are required to complete all requirements for teacher certification, and to hold the appropriate certificates for the subjects they teach.

Certification has been used as a tool to promote teacher quality. More than 98 percent of Kentucky teachers are considered highly qualified and are certified in their subject areas.

More than 98 percent of teachers in Kentucky are considered highly qualified by federal standards and are properly teaching in their areas of certification. Kentucky minimizes out-of-field teaching by requiring teachers to have certifications in their teaching areas.

The research on the value of teacher certification in promoting higher student achievement is inconclusive.

The research on the value of teacher certification in promoting higher student achievement is inconclusive. Some researchers found that states with larger percentages of certified teachers are associated with higher test scores (Darling-Hammond, Berry, and Thoreson). Studies have not found a strong relationship between certification and the impact of teachers on student performance (Angrist; Betts). A study of Chicago students found that traditional quality indicators that are used to set teacher compensation, such as certification, explain little of the variation in teacher quality (Aronson).

The debate about certification also includes several studies that analyze the impact of noncertified Teach For America instructors on student performance. Teach For America is a nontraditional program that places high-quality college graduates in hard-to-staff urban schools. In many cases, the Teach For America personnel have no background in education studies and are not certified by state licensure agencies. Several studies have found that Teach For America personnel have achieved stronger student gains in mathematics than other teachers, including traditionally certified teachers (Xu; Decker). However, another study found that noncertified teachers in Houston, including Teach For America personnel, produced lower mathematics and reading gains than did certified teachers (Darling-Hammond, Holtzman, Gatlin, and Heilig).

Without a data system that links teachers to individual student performance, an analysis on the impact of certification on student performance is not possible.

Similar studies on the impact of certification on student mathematics performance in Kentucky have not been conducted. Without a data system that links teachers to individual student

performance, an analysis of the role of certification on student performance is not possible.

Content Knowledge and Pedagogical Content Knowledge

A critical factor in mathematics achievement is teacher pedagogical content knowledge—a teacher’s ability to explain and teach complex concepts to diverse learners.

Researchers now recognize that traditional measures of mathematics content knowledge do not measure an individual’s ability to teach mathematics content effectively. In mathematics, for example, straightforward content knowledge tests do not distinguish between a teacher’s understanding of a specific mathematical concept and that teacher’s ability to teach the concept to a wide range of students.

Pedagogical content knowledge is a specialized form of knowledge required for teaching that includes the ability to represent concepts using a variety of methods and the ability to anticipate and understand student failure to learn specific concepts.

The term “pedagogical content knowledge” describes a specialized form of content knowledge required for teaching; it includes qualities such as the ability to represent concepts using a variety of methods and the ability to anticipate and understand students’ ways of understanding and misunderstanding specific concepts (Shulman). The term combines general pedagogical principles with content in specific academic disciplines.

Researchers are in the process of developing standardized measures of teachers’ pedagogical content knowledge in mathematics. While many recognize the importance of distinguishing between content knowledge and pedagogical content knowledge, debate continues within the research community about whether and how pedagogical content knowledge can be validly and reliably assessed. There is some indication, however, that measures of pedagogical content knowledge may be useful for studying the relationship between teacher quality and student achievement. A group of researchers documented relationships between what it called “mathematical knowledge for teaching” of 1st- and 3rd-grade teachers and achievement gains of students in these teachers’ classes (Ball, Hill, and Rowan).

The acquisition of pedagogical content knowledge by preservice teachers and inservice teachers has implications for teacher training. The goal is to produce more teachers who know how to improve student mathematics achievement, not teachers who are only content knowledge experts.

Pedagogical content knowledge has important implications for teacher preservice training, professional development, and continuing education. In the past, efforts to improve the quality of mathematics teachers were more likely to focus on the quantity and rigor of mathematics courses than on the relationship between mathematics courses and effective teaching. One researcher put it this way:

The goal is not to produce teachers who know more mathematics. The goal is to improve students’ learning. Teachers’ opportunities to learn must equip them with the

mathematical knowledge and skill that will enable them to teach mathematics effectively (Ball. “Mathematics” 1).

In mathematics, the importance of content knowledge is not debated. Researchers have found strong relationships between teacher mathematics content knowledge and student achievement (Hill; Ma). Educator preparation programs have reacted to the content knowledge pedagogy literature by introducing new classes for elementary, middle, and secondary mathematics teachers to prepare them for the challenges they will face in the classroom.

Most researchers agree that pedagogical content knowledge is important. However, critics of teacher education believe that the teaching profession should be open to more content knowledge experts who are not interested in traditional majors in education studies.

While most agree that pedagogical content knowledge is important, mathematics educators continue to debate the relative balance between mathematics content knowledge and pedagogy. Critics of educator preparation programs believe that the field of teaching should be opened up to content knowledge experts who lack pedagogical training (Hanushek. Telephone interview). They believe that mathematics teachers should be mathematics majors, that biology teachers should be biology majors, but that education courses could be covered without completion of a major in education. These critics contend that opening the teaching field to highly qualified applicants who lack education degrees would potentially increase teacher content knowledge. Some efforts to open the teaching field to content knowledge experts have been made by EPSB through the alternate routes to certification.

Staff interviews with school administrators found that most believe that the middle school and high school content knowledge of Kentucky teachers is sufficient.

In Kentucky, secondary and middle school mathematics teachers are required to take a substantial number of mathematics courses. Most educator preparation programs also require multiple mathematics pedagogy courses. Staff interviews with school administrators found that many believe that middle school and secondary school mathematics teachers have ample content knowledge in Kentucky.

District and school administrators interviewed during OEA site visits raised concerns about whether high school teachers are prepared to teach using methods likely to be effective with all students. When asked to explain why mathematics proficiency rates are low in high schools, the overwhelming majority of district and school administrators cited lack of student motivation and outmoded teaching methods as major factors. Some administrators attributed lack of student motivation, in part, to competing student interests such as jobs, extracurricular activities, and dating.

Many high school teachers still deliver mathematics content using lectures. They are less able to adapt content to meet student needs.

Those administrators also felt that most high school teachers could be doing more to engage student interest in mathematics; many teachers still rely primarily on lecture format and are not comfortable employing group work, project work, manipulatives, models, or other alternative teaching formats. Several administrators commented that high school mathematics teachers, as a group, are most comfortable teaching in the way that they learned mathematics. They are less able to adapt content for students who have difficulty thinking abstractly, processing multistep problems, or seeing real-world relevance to mathematical concepts. Both administrators and teachers reported great difficulty making Algebra II relevant and interesting to all students.

Administrators' views of teacher preparation for elementary and middle school mathematics teachers were mixed. While some expressed concerns similar to those already discussed, others were enthusiastic about younger teachers' skills. Several districts have ongoing relationships with local postsecondary institutions and have given input into the redesign of teacher training programs.

Most teachers interviewed did not identify lack of preservice pedagogy training as a problem. Many reported learning more about teaching pedagogy through trial and error or learning from colleagues than from educator preparation programs.

Most teachers interviewed did not identify lack of preservice pedagogy training as a problem; however, the overwhelming majority of teachers at all levels explained that they learned more about mathematics teaching methods from trial and error in their classrooms or from colleagues than they did from their educator preparation programs. There were a few notable exceptions. For example, several newly certified high school mathematics teachers stressed the importance of the pedagogical training they had gotten from an educator preparation program that had been reorganized to address mathematics teaching issues.

Test Scores

Other traditional indicators of teacher quality include test scores. By the time college students graduate, they may have taken tests such as the ACT, the SAT, and the GRE. Frequently, test results are used by colleges to determine student program admission or eligibility for scholarships. Most college entrance exams are designed to predict the likelihood of succeeding in college, not future job performance. For example, an ACT score received by a 17-year-old high school student would not necessarily be a strong predictor of teacher success because it neglects 4 years of targeted teacher training obtained at the university.

Education majors tend to have scored within the middle distribution of ACT scores.

The highest possible score on the ACT examination is 36. One teacher quality researcher found that nationally, teachers tended to

score within the middle distribution of ACT scores when they took the exam in high school. The majority of teachers scored between 22 and 27 (Noell, Telephone interview). This distribution is typical of most college majors. Colleges of education in Kentucky typically require applicants to have a minimum ACT score of 21 for admission to an educator preparation program. For students who score below that threshold, alternative options, including additional testing or demonstrated high academic performance at the university level, may lead to admission.

A CPE analysis of ACT scores by college major found that education majors performed slightly lower than many other majors.

Table 4.3 shows composite ACT scores by major for students at Kentucky public colleges and universities in 2004. Majors in engineering, foreign languages and literature, physical sciences, and biological sciences had the highest mean (or average) composite ACT scores, above 25. Majors in education, health professions, and liberal arts and sciences had the lowest mean composite scores, below 22. The average ACT scores of education majors in Kentucky is lower than the average ACT scores of many other majors. It seems that education majors in Kentucky are barely meeting the minimum requirements for admission to educator preparation programs.

Table 4.3
Composite ACT Score by Select Major
Kentucky Public Colleges and Universities, 2004

Major	Mean Composite Score
Engineering	26.4
Foreign languages and literature	25.6
Physical sciences	25.5
Biological sciences	25.4
Philosophy and religion	25.0
Mathematics	25.0
English language and literature	25.0
Computer and information sciences	23.3
Social sciences and history	23.3
Law and legal studies	22.8
Business management and administrative services	22.3
Communications	22.1
Education	21.3
Health professions	21.1
Liberal arts and sciences, general studies and humanities	19.7

Notes: Only includes students with available scores who were enrolled in Fall 2007 with ACT scores from 2004. The “mean score” is the average of all students in a declared major.

Source: Staff compilation of Council on Postsecondary Education data.

Grade Point Average

While some research has focused on the relationship between college grade point averages and teacher effectiveness, there is no statistically significant data to support one argument over another. In Kentucky, data on college grade point averages for teachers already in the classroom are not routinely collected; therefore, no analysis can be made of individual teachers, their GPAs, and student performance.

Conclusion

Teacher quality is considered essential to student achievement, yet there is no consensus on the combination of attributes that make a teacher successful.

Most researchers agree that teacher quality is the most important factor affecting student achievement. Studies have shown that student exposure to ineffective teachers has strong negative impacts on mathematics learning (Sanders and Rivers). Yet few researchers agree on what indicators are associated with high-quality teaching. The data are inconclusive on the relationship between teacher experience, certification, master's degrees and content knowledge and student achievement. This has led some researchers to conclude that the field of teaching should be open to content knowledge specialists who lack traditional teacher training (Hanushek. Telephone interview). Others counter that traditional education studies remains a vital component for ensuring teacher quality (National Education). Development of a robust P-20 data system would enable researchers to link individual teachers to individual students to determine a teacher's impact on achievement gain. Kentucky is working on such a system, but it has not been implemented.

Chapter 5

Other Issues Affecting Teacher Quality

Teacher Quality in Context

Program standards for educator preparation programs are in place, but the performance of Kentucky's K-12 students in mathematics creates the impression that the quality of mathematics teachers could be higher.

Kentucky has quality control mechanisms to ensure that the teaching force is competent and effective. Educator preparation programs must be accredited, and teachers must hold a valid teaching certificate. Despite these efforts, student mathematics scores do not reflect high achievement, which suggests that mathematics teachers could be more effective in the classroom.

This chapter focuses on several issues that affect teacher quality, including P-20 education, supply, compensation, evaluation systems, working conditions, and methods used in other countries. It is important to keep international comparisons in their proper cultural context.

Researchers agree that teacher quality is dependent on multiple variables such as content knowledge, mentoring, collaboration, school leadership, and instructional innovation.

It is impossible to isolate the fundamental attributes of a highly effective teacher and realistically expect educator preparation programs to mass produce high quality teachers. As the research shows, teacher quality is partly innate, but it also depends on content knowledge, mentoring, collaboration, school leadership, and instructional innovation. All of these variables contribute to the ability of a teacher to be effective and relevant to students. Yet critics of teacher education programs agree that an array of strategies are available to make educator preparation programs stronger.

The P-20 System

Teacher quality is a P-20 concern because most Kentucky teachers are educated in the public education system.

Because the majority of Kentucky's teachers are educated in Kentucky's public primary and secondary education system, reform measures related to teacher quality require a comprehensive approach.

Mathematics education reforms in Kentucky will ultimately involve all participants in the P-20 system. Reform measures such as Senate Bill 1 and the requirement of the ACT are efforts to prepare highly qualified high school graduates for college. These reforms will directly impact the quality of individuals available to be trained as K-12 teachers. Similarly, improvements made by EPSB to master's degree programs should produce graduates with

improved knowledge in content and teaching pedagogy, thereby impacting the quality of the current teaching force.

In order to evaluate the success of new education initiatives, a comprehensive P-20 database is needed.

While the state continues to make changes intended to improve the quality of the K-12 and higher education systems, concerted efforts to collect and share data, monitor implementation, and report findings are needed. Without such efforts, it will be impossible to tell which initiatives are successful and which measures do not meet the state goals of improvement. The P-20 database under construction between a partnership of EPSB, CPE, and KDE is critical to program evaluation. Without good data, the quality and value of these initiatives cannot be measured.

Mathematics Teacher Supply

National studies suggest that the supply of qualified mathematics teachers is low. In Kentucky, more than 98 percent of teachers are considered highly qualified and are certified to teach in their respective disciplines.

An analysis of STEM degrees granted in the US found a low supply of professionals in these disciplines. The limited supply of these professionals has implications for school systems. Nationwide, studies have found high numbers of mathematics teachers in hard-to-staff schools who teach out of field (Ingersoll. “Is”; National Council. *Tackling*). Table 5.1 shows that the percentage of courses taught by highly qualified mathematics teachers is high in Kentucky, regardless of school poverty level.

Table 5.1
Percentage of Courses Taught by Highly Qualified Teachers
by School Poverty Level, Spring 2009

School type	Elementary Courses	Mathematics Courses
High poverty	99.5%	97.6%
Mid poverty	99.6%	98.2%
Low poverty	99.7%	98.5%
All Schools	99.6%	98.2%

Note: The remainder of the percentages of courses taught reflects courses taught by out-of-field teachers and by those with emergency certification.

Source: Commonwealth. Education. Highly.

School administrators in geographically isolated districts reported difficulty finding mathematics and physics teachers.

District and school administrators interviewed during OEA site visits described limited supplies of middle and high school mathematics teachers. Administrators reported greater difficulty finding high-quality high school mathematics teachers than any other type of teacher, except physics teachers. Several principals worried that they would not be able to replace retiring mathematics teachers with equally effective teachers. Others cited low numbers of applicants for posted high school mathematics positions, contrasted with dozens of applicants for high school social studies

positions. As a result of low supply in some areas, administrators reported hiring teachers who would not normally be their first choice.

These hirings included certified teachers for grades 5-9 who were qualified only to teach Algebra I or teachers who did not appear to have the personal characteristics that would make them effective with students. In one case, a high school principal reported covering a high school mathematics class with a long-term substitute teacher for almost a year.

Schools in geographically desirable areas or in districts with higher teacher pay have less difficulty hiring and retaining qualified mathematics teachers.

The magnitude of the mathematics teacher supply problem varies by school and district. Schools in remote areas and in districts where teacher salaries are lower than those in surrounding districts reported the greatest difficulty attracting and retaining any high school mathematics teachers. In contrast, schools located in geographically desirable areas, in areas close to teacher training institutions, or in districts that paid more than surrounding districts experienced less challenge attracting qualified applicants.

One argument is that the annual number of new mathematics teachers is sufficient to offset the loss of retiring mathematics teachers. However, the supply does not offset the loss of mathematics teachers to both retirement and attrition.

The literature on the supply of mathematics teachers largely supports the supply crisis argument. Many analysts believe that the US is not producing enough mathematics teachers to meet emerging demand. One research team analyzed the shortage of mathematics teachers and concluded that the issue is misunderstood. The researchers analyzed national data and found that the number of new mathematics teachers produced annually is sufficient to offset the loss of mathematics teachers to retirement. However, the supply of new mathematics teachers is not enough to cover the loss of mathematics teachers to both retirement and attrition. The authors recommended renewed focus on retaining existing mathematics teachers in addition to focusing on building new teacher supply (Ingersoll and Perda).

A study by CPE found that Kentucky is producing insufficient numbers of teachers in science, technology, engineering, and mathematics.

In Kentucky, CPE has analyzed the challenges associated with producing STEM graduates (Commonwealth Council, Kentucky's). While this analysis did not focus solely on mathematics teachers, CPE concluded that Kentucky is producing insufficient numbers of teachers in STEM disciplines. CPE connects Kentucky's lack of STEM graduates to the state's weak competitiveness in the global economy.

Kentucky increased the mathematics requirements for high school graduation courses starting with the class of 2012 (704 KAR 3:305). Students will be required to take mathematics for 4 years and complete classes in Algebra I, Geometry, and

Algebra II. More students taking more classes in mathematics likely will require more qualified mathematics teachers at schools throughout Kentucky.

To address the question of mathematics teacher supply in Kentucky, staff analyzed 5 years of Local Educator Assignment Data (LEAD). The LEAD database includes teacher certification, teacher experience, and teacher assignment information. Staff analyzed changes in the LEAD database for the school years 2005 through 2009. The database includes all teachers who teach mathematics courses in middle schools and high schools. Table 5.1 shows the experience levels of high school mathematics teachers in Kentucky over the last 5 school years. The number of high school mathematics teachers has increased from 1,667 in 2005 to 1,779 in 2009. During that period, the percentage of teachers with fewer than 5 years of experience increased from 22.6 percent to 28.3 percent. In 2009, 10.3 percent of high school mathematics teachers, or 183 teachers, had more than 25 years of experience.

Staff analysis of Local Educator Assignment Data suggests that Kentucky is not facing an imminent high school mathematics teacher supply crisis. However, the supply of mathematics teachers in the least-experienced cohort is growing, and teachers with 5 to 14 years of experience is shrinking.

Table 5.2 suggests that Kentucky is not facing an imminent mathematics teacher retirement crisis. However, the increase in the percentage of teachers with fewer than 5 years of experience, coupled with the decrease in the percentage of teachers with 5-14 years of experience, suggests that more Kentucky students are being taught by less experienced teachers and that mid-career mathematics teachers are leaving the profession. Because novice teachers are associated with lower student performance, having more experienced teachers could be associated with lower student performance.

Table 5.2
High School Mathematics Teachers by Years of Experience
School Years 2005-2009

School Year	Years of Experience						Total
	<5	5-9	10-14	15-19	20-24	>25	
2005	22.6%	21.1%	20.2%	13.5%	9.1%	13.6%	1,667
2006	26.0%	19.0%	20.7%	13.0%	9.9%	11.4%	1,741
2007	27.4%	18.6%	19.1%	13.4%	10.1%	11.4%	1,744
2008	26.5%	18.8%	18.1%	15.3%	10.6%	10.6%	1,756
2009	28.3%	17.7%	18.3%	15.0%	10.4%	10.3%	1,779

Source: Staff compilation of Local Educator Assignment Data obtained from the Education Professional Standards Board.

The percentage of middle school mathematics teachers with fewer than 5 years of experience grew by 6 percentage points between 2005 and 2009; the percentage of teachers with 5 to 14 years of experience declined.

The experience level of Kentucky’s middle school mathematics teachers is similar to that of high school mathematics teachers. Table 5.3 shows that since 2005, the percentage of middle school mathematics teachers with fewer than 5 years of experience has increased, while the percentage of middle school mathematics teachers with more than 25 years of experience has decreased. Almost one-third of all middle school mathematics teachers have taught for fewer than 5 years. Almost 9 percent, 120 of the 1,355 middle school mathematics teachers in Kentucky, have more than 25 years of experience and are either eligible or almost eligible for retirement.

Table 5.3
Middle School Mathematics Teachers by Years of Experience
School Years 2005-2009

School Year	Years of Experience						Total
	<5	5-9	10-14	15-19	20-24	>25	
2005	25.1%	22.6%	17.1%	14.6%	9.4%	11.2%	1,312
2006	27.2%	20.9%	16.7%	14.8%	9.1%	11.3%	1,331
2007	29.3%	20.5%	15.7%	14.4%	10.0%	10.0%	1,373
2008	29.6%	19.6%	17.0%	13.7%	10.3%	9.7%	1,355
2009	31.6%	17.9%	16.0%	14.0%	11.6%	8.8%	1,365

Source: Staff compilation of Local Educator Assignment Data obtained from the Education Professional Standards Board.

The number of middle school mathematics teachers has increased from 1,312 in 2005 to 1,365 in 2009. The number of high school mathematics teachers has increased from 1,667 in 2005 to 1,779 in 2009. Kentucky has increased the number of mathematics teachers in middle and high schools with the use of emergency certification and alternative certification routes.

A serious issue highlighted in the data is attrition. The number of mathematics teachers by age cohort decreases for each incremental increase in years of experience. Some of these teachers are advancing into school administrative roles and leadership positions. Others are likely leaving the profession altogether. Neither KDE nor EPSB tracks attrition data on a regular basis.

Recommendation 5.1

Recommendation 5.1 is that KDE and EPSB should jointly develop a formula to accurately determine teacher shortage areas, long-term trends, and the hiring needs of the state with a focus on ensuring that teacher availability and quality are equalized across the state.

The Kentucky Department of Education and the Education Professional Standards Board should jointly develop a formula to accurately determine teacher shortage areas, long-term trends, and the future hiring needs of the state. The formula should focus on ensuring that teacher availability and quality are equalized across the state. These agencies should report their findings to the Education Assessment and Accountability Review Subcommittee by June 2011.

Teacher Pay

Teacher quality and teacher supply are, to a degree, linked to teacher compensation. Yet teacher compensation is determined by years of experience and education levels that are weak predictors of teacher quality.

The issue of teacher quality cannot be separated from teacher compensation. Research suggests that educator preparation programs are having difficulty attracting the best college students into the teaching field (Corcoran). High-performing teachers are associated with student performance gains that can overcome achievement gaps between economically disadvantaged students and students from more affluent backgrounds (Rivkin). The primary determinants of teacher compensation—years of experience and education levels—are not strong predictors of teacher effectiveness beyond the first three years of a teacher’s career. Many states and school districts are exploring new compensation strategies in an effort to attract highly skilled and motivated instructors.

Differentiated pay is the norm in higher education. Professors in fields with high demand and low supply are typically paid more than professors in lower-demand, higher-supply disciplines. Pay is also influenced by private-sector options. Salaries for engineering faculty are typically higher than salaries for English professors.

At the university level, compensation plans are different than in K-12 systems. Professors in disciplines with high demand and low supply are paid higher salaries than professors in lower-demand, higher-supply fields. For this reason, it is common for professors of business, law, and information technology to make considerably more in salary than do professors of English, philosophy, and history. This compensation method is known as differentiated pay and is used in many industries to attract and retain skilled employees who have highly marketable skills.

Table 5.4 compares annual average wages of university professors in selected disciplines in Kentucky. The data show substantial differences in annual average wages at postsecondary institutions. Years of experience are a factor in postsecondary wages, but the large spread between subject areas suggests that experience is not the driving factor behind wages. Universities typically use faculty evaluations that include research productivity to identify and reward exceptional performance above and beyond annual cost of living adjustments to wages.

Table 5.4
Comparison of Average Annual Wages of Professors in
Postsecondary Institutions in Kentucky, May 2008

Discipline	Average Annual Wage
Engineering	\$98,560
Economics	\$90,020
Business	\$81,940
Computer science	\$70,060
Biological sciences	\$69,270
Political science	\$66,690
Sociology	\$60,250
English	\$57,420
Geography	\$57,240

Source: U.S. Bureau of Labor Statistics. May 2008 Occupational Employment and Wage Estimates.

Kentucky’s public schools could implement a system of differentiated pay to attract and retain highly qualified mathematics teachers, but little research on the effectiveness of the strategy is available.

International analyses have found that many high-performing school systems front-load their compensation packages with attractive starting salaries to compete with entry-level salaries in other industries. In Finland, the difference between the starting teacher salary and the highest possible salary is just 18 percent. This method of compensation attracts strong performers into the system at an early age and retains those dedicated to teaching (McKinsey).

Starting salaries for teachers in science and mathematics are lower than salaries for those disciplines in the private sector.

Educator preparation programs compete with science, technology, engineering, and mathematics departments for high-performing mathematics students. National surveys of starting salaries show that teaching careers, on average, offer lower starting salaries and diminished career earnings compared to other careers in STEM disciplines. Table 5.5 shows national data on average starting salaries and average salaries by college major. Most fields that require strong mathematics backgrounds pay significantly higher wages than do positions in public education, and they offer the opportunity to earn salaries much higher than those in the teaching profession. This analysis ignores compensation factors like retirement contributions and annual leave, but it highlights the economic challenges of attracting high-performing professionals from STEM disciplines to become mathematics teachers.

Table 5.5
U.S. Comparison of Starting Salaries and
Average Salaries by Major, 2009

Degree	Starting Salary	Average Salary
Computer engineering	\$61,700	\$105,000
Electrical engineering	\$60,200	\$102,000
Economics	\$50,200	\$101,000
Statistics	\$48,600	\$94,500
Mathematics	\$47,000	\$93,600
Information systems management	\$51,900	\$87,200
Education	\$36,200	\$54,100

Source: PayScale.com. 2008-2009 College Salary Report.

Researchers have not reached consensus on the level of pay that is needed to attract and retain STEM candidates in hard-to-fill positions or in hard-to-fill schools.

There is no consensus on the level of pay that is needed to attract and retain STEM candidates in hard-to-fill positions or in hard-to-fill schools. A certain percentage of undergraduates in technical fields would likely never change majors to become teachers. North Carolina initiated a program to pay qualified teachers an \$1,800 bonus in order to reduce teacher turnover rates. The result was about a 12 percent drop in teacher turnover rates in hard-to-staff positions or hard-to-staff schools (Clotfelter, Glennie, Ladd, and Vigdor). Some researchers suggest that differentiated pay in the range of \$10,000 to \$15,000 is needed to compete with the private sector for STEM personnel (Goldhaber, Gross, and Player). One review of compensation reform concluded that school districts cannot ignore labor market realities. Graduates with technical degrees command higher salaries in the marketplace than can graduates from other disciplines. To successfully compete for highly skilled graduates, salaries for STEM teachers must reflect market realities (Goldhaber. *Teacher*).

Performance Pay

Another topic debated by education researchers is the role of performance pay, also known as pay for performance, in identifying and rewarding high-quality teachers. Implementing a pay-for-performance program would require an integrated database that allows individual students to be linked to individual teachers. This would allow an analysis of teacher effectiveness relative to student performance. Called a value-added methodology, such a method “measures how individual teachers influence learning for each child” (Berry and Fuller). Determining teacher’s effectiveness depends on a comprehensive database and advanced statistical analysis of student performance data. The value-added method can also be used to determine which educator preparation programs

produce teachers who consistently demonstrate the ability to achieve high student performance (Noell and Burns).

Performance pay rewards individual teachers for achieving student performance gains.

A survey of school administrators in 45 states found that roughly 45 percent of the respondents expressed moderate to strong interest in exploring pay-for-performance initiatives (American Association).

Problems With Value-added Methodology

Value-added measurement depends on standardized testing to gauge a teacher's impact on student learning. However, the methodology cannot capture subtle and hard-to-quantify impacts of teachers on students.

Value-added methodology depends on standardized testing to measure teacher effectiveness. Yet, teacher value is multifaceted, and value-added methods do not measure a teacher's impact on a student's life. For instance, a teacher who convinces a potential dropout to remain in school would not be rewarded using value-added methods. The reliance on standardized testing to gauge teacher performance fails to adequately measure the impact of teachers in subjects like physical education, home economics, drama, art, music, social studies, and other disciplines that are not subject to accountability testing. Measuring the value of a teacher is dependent on the quality of standardized tests; in many states, students are not tested in every grade and every subject (Rothstein).

Another problem with value-added methodologies is that teachers are not randomly assigned students. Teachers who are consistently assigned lower-performing students might be unfairly singled out for failing to achieve high student performance gains.

Another problem with the value-added methodology is self-selection. Teachers are not randomly distributed across schools, and students are not randomly assigned to classes. Research shows that high-performing teachers choose to work in high-performing schools with fewer socioeconomic challenges rather than choosing to work in low-performing schools (Jackson). If some teachers are consistently assigned lower-performing students, rewards based on achievement gains might not be fairly allocated in a pay-for-performance system.

Critics of pay-for-performance systems also point out that individual teacher rewards could undermine teacher cooperation and collaboration, which is an emerging strategy to build strong schools. However, pay-for-performance programs could be designed to award teams and not just individual teachers (Schuermann).

Despite weaknesses, the value-added methodology could be a valuable tool in a more comprehensive educator evaluation system.

Despite the weaknesses of value-added models, researchers tend to agree that it could be a valuable tool in developing more comprehensive teacher evaluations. Tennessee has been collecting value-added data for years, and several school districts across the

country are experimenting with performance pay initiatives (Hershberg).

Kentucky and Compensation Reform

KRS 157.075 permitted the establishment of a differentiated pay pilot program, but it was never fully funded and has not been a catalyst for implementing differentiated pay across the state.

Kentucky experimented with differentiated pay during the 2002-2004 biennium. KRS 157.075 mandated the development of differentiated compensation programs to recruit and retain teachers in critical shortage areas; to provide incentives for teachers to serve in hard-to-fill positions; and to reward teachers who increase their knowledge, skills, and instructional leadership. The statute was supposed to fund at least five school district pilots, but the program was never fully funded. The acting education commissioner at the time used \$2 million of available federal teacher quality money to fund the program (Commonwealth. Education. Staff Notes).

In 2003, the Kentucky Board of Education promulgated 702 KAR 3:310 to define the factors to be considered in developing differentiated compensation plans and approving requests for funding. Ten proposals were chosen from a pool of 32 applications. The approved plans provided

- stipends and professional development for student achievement coaches for each school;
- tuition reimbursement for teachers in critical shortage areas;
- training for mentors;
- extra-duty pay for teachers in critical shortage areas;
- substitute pay, trainers, and materials; and
- extended days to the school calendar for professional development.

Only one district proposed using funds to pay bonuses to classified and certified staff to work at a hard-to-staff school.

Kentucky has also experimented with other compensation innovations. As part of the Kentucky Instruction Results Information System of 1990, schools could earn funds for exceeding their performance goals. The program allocated more than \$43 million to schools from fiscal year 1991 to FY 1994. In 1996, as part of the Commonwealth Accountability Testing System, school rewards continued. From FY 1996 through FY 2003, about \$68 million was allocated for school awards.

Teacher Evaluations

An accurate evaluation system is needed to ensure fair compensation. Reviews of state teacher evaluation systems have found that teachers are rarely removed because of poor performance.

In order to implement fair compensation reforms, teachers need to be accurately evaluated. Reliable data and multiple measures of teacher effectiveness should be taken into consideration when designing an evaluation system. Kentucky does require a standardized teacher evaluation instrument, but districts design their own evaluation protocol subject to KDE approval. Kentucky teachers are granted tenure after 4 years of consecutive service in the same district (KRS 161.740). The majority of states grant tenure after 3 years of service. Critics contend that tenure in Kentucky and other states is almost always granted.

Coaches have a variety of measurements they use to assess the productivity of a player. Parents have no similar measure to use in gauging the effectiveness of their child's teacher. A recent report labeled teachers as "widgets," interchangeable parts that deliver similar or the same education quality to all students because they almost all receive satisfactory evaluations (Weisberg). National data show that 99 percent of teachers receive satisfactory ratings on performance evaluations used by school systems. This type of evaluation system masks serious problems affecting teacher quality when considered with the vast range of student assessment performance data. Teachers who are considered satisfactory are not singled out for remediation or for targeted professional development to improve their deficiencies.

Working Conditions

In addition to compensation, teacher working conditions are an important variable associated with teacher job satisfaction and morale.

While teacher compensation is an important part of retaining high quality teachers, the working conditions of teaching professionals is associated with both teacher retention and student performance. The Center for Teaching Quality surveyed more than 250,000 teachers and found that those who plan on leaving the teaching profession are more likely to have concerns about lack of empowerment, poor school leadership, and low levels of trust and respect within their schools (Berry, Smylie, and Fuller). The Connecticut Center for School Change concluded that teachers leave schools for many nonmonetary reasons, such as managerial conflicts, loss of creativity, and challenging relationships inside and outside the classroom (Reichardt). Others point out that many teachers choose to work at private schools that pay significantly lower salaries than public schools pay, most likely because of better working conditions (Hanushek and Rivkin. "School").

Older facilities that lack modern amenities fail to create an environment conducive to teaching and learning. In addition, quality school leadership that empowers teachers is a critical factor in teacher satisfaction.

The quality of school facilities is associated with teacher retention. Many older schools lack modern amenities, suffer from disrepair, and do not create an environment conducive to teaching and learning (Buckley). Teacher autonomy and school leadership are also factors that affect teacher job satisfaction. Teachers who do not feel empowered by leadership typically leave the profession at higher rates than teachers who feel valued by peers and leaders (Bogler; Tschannen-Moran).

North Carolina has been a leader in researching teacher working conditions. As part of the North Carolina Teacher Working Conditions Initiative, educators across the state are annually surveyed on working conditions. In 2008, 87 percent (more than 104,000) of the state's educators participated in the survey. The survey found that supportive school leadership, sufficient facilities and resources, time for teachers to plan and collaborate, time for teachers to focus on students without interruption and for additional duties, an atmosphere of mutual trust, and strong school improvement teams are associated with higher student achievement. These attributes were viewed as important variables in teacher retention (State of North Carolina).

Teacher Preparation in Other Countries

One study analyzed school performance in several European, Asian, North American, and Middle Eastern countries. The study focused primarily on the school system itself, not on pedagogy or curriculum. According to the study, there are three primary features of high-performing systems:

- getting the right people to become teachers;
- developing them into effective teachers; and
- ensuring that the system is able to deliver the best possible instruction for every child (McKinsey).

A study found that the best-performing school systems attract high-quality candidates into teacher training programs. In South Korea, Singapore, Finland, and Hong Kong, teachers are recruited from the top third of high school students.

In some countries, teachers are recruited from the top tier of high school students. In Kentucky, data indicate that education majors score lower than many other majors on the ACT. Most Kentucky educator preparation programs do not attract the highest quality of college students, if ACT scores are an indicator of teacher aptitude. In Singapore, only 1 out of every 6 applicants is selected to become a teacher; in Finland, it is only 1 out of every 10 applicants. Failure to control the supply of teachers can lead to an oversupply of marginally qualified candidates and lower wages (McKinsey). Kentucky's best high school graduates, as suggested by ACT scores, often bypass entry into teacher training programs in favor of more challenging majors with higher earning potential.

Establishing more avenues for entry into the teaching profession by increasing the availability of alternative certifications likely would increase the pool of highly qualified teachers. Some requirements in Kentucky, such as additional courses in teacher pedagogy, content assessments, or internships, may be considered barriers to professionals seeking to change careers. While changing the existing certification process would be difficult, many reformers are pushing states and educator preparation programs to rethink how teachers are selected and trained.

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Appendix A

Praxis II Mathematics Exams

Exam (Cost)	Purpose	Time	Number of Questions/type(s)	ETS Expected Ranges Based on US Data	Concepts/Constructs (Proportion of exam)
Praxis I: Pre-professional Skills Test: Mathematics (\$40)	Gauges basic reading, writing, and mathematics skills of preprofessional educators; often used as an entry requirement for educator preparation programs	1 hour	40 multiple-choice	Possible range: 150-190 Average performance range: 174-184	<ul style="list-style-type: none"> Number and operations (32.5%) Algebra (20%) Geometry and measurement (22.5%) Data analysis and probability (25%) Calculator use is prohibited
Praxis II: Elementary Education: Content Knowledge (\$80)	Gauges general content knowledge of prospective elementary educators (primary through upper elementary grades)	2 hours	120 multiple-choice with 30 in each of four content areas: reading/language arts, mathematics, social studies, and science	Possible range: 100-200 Average performance range: 151-176	Math-related concepts tested <ul style="list-style-type: none"> Mathematical processes: Number sense and numeration (40%) Algebraic concepts (25%) Informal geometry and measurement (20%) Data organization and interpretation (25%) Scientific or four-function calculator use is permitted. Parenthetical proportions listed above are relative to the mathematics section of this four-subject exam.
Praxis II: Mathematics Content Knowledge (\$80)	Gauges math content knowledge of beginning secondary school mathematics teachers (who typically possess a bachelor's degree in mathematics or mathematics education)	2 hours	50 multiple-choice	Possible range: 100-200 Average performance range: 128-159	<ul style="list-style-type: none"> Algebra and number theory (16%) Measurement (6%) Geometry (10%) Trigonometry (8%) Functions (16%) Calculus (12%) Data analysis and statistics (10%-12%) Probability (4%-6%) Matrix algebra (8%-10%) Discrete mathematics (6%-8%) Graphing calculator required.

Praxis II: Middle School Mathematics (\$90)	A middle school mathematics educator certification exam; test takers typically hold bachelor's degrees with an emphasis in mathematics education, mathematics, or education	2 hours	40 multiple-choice and 3 short constructed response items	Possible range: 100-200 Average performance range: 149-174	<ul style="list-style-type: none"> • Arithmetic and basic algebra (20%) • Geometry and measurement (17%) • Functions and their graphs (13%) • Data, probability, and statistical concepts; discrete mathematics (17%) • Problem-solving exercises (33%) Graphing calculator is permitted; however, calculators with QWERTY keyboards are prohibited.
Praxis II: Mathematic: Proofs, Models, and Problems (\$80)	A middle school mathematics educator certification exam; test takers typically hold bachelor's degrees with an emphasis in mathematics education or mathematics	1 hour	4 basic exercises: 1 proof, 1 model, and 2 problems	Possible range: 100-200 Average performance range: 148-178	<ul style="list-style-type: none"> • Problems (40%) • Model (30%) • Proof (30%) Assessed competencies include <ul style="list-style-type: none"> • Mathematical problem solving • Mathematical reasoning and proof • Mathematical connections • Mathematical representation • Use of technology Graphing calculator is required for this exam; however, QWERTY keyboards are prohibited.
Praxis III	Designed to gauge beginning educators' performance in classroom settings and to provide insights into pedagogical content knowledge of a teacher to pinpoint areas of improvement.	Variable; depends on individual state's requirements/processes	In-action assessment with a variable amount of observation points	NA	Key observational constructs include planning to teach, classroom environment, instruction, and professional responsibilities.

Source: Educational Testing Services.

Appendix B

Teacher Mathematics Requirements by Educator Preparation Institution

Institution	Total Credit Hours Required by Specialization		
	Elementary Requirements	Middle School	Secondary Math
Alice Lloyd College	9 (no algebra) or 24 w/math emphasis	25	36
Asbury College	12 (no algebra)	27	36
Bellarmino University	9 (no algebra)	24	42+
Berea College	6 (no algebra)	na	36
Brescia College	9 (no algebra)	25-27	36
Campbellsville University	9 (no algebra)	25 or 38	36
Centre College	6 (no algebra)	na	36
Georgetown College	9 (no algebra)	24	36
Kentucky Christian College	9 (no algebra)	29	na
Kentucky Wesleyan College	9 (no algebra) or 21 w/math emphasis	21	30
Lindsey Wilson College	9 (no algebra)	26	36
Mid-Continent University	9 (no algebra)	na	na
Midway College	6 (no algebra) or 21 w/ math emphasis	26	30
Pikeville College	9 (no algebra)	33	36
St. Catherine	9 (no algebra)	na	na
Spalding University	9 (algebra required)	31	na
Thomas More College	18 math emphasis	21	36
Transylvania College	6 (no algebra)	24	18 (math minor)
Union College	9 (no algebra) or 21 w/math emphasis	21	30
University of the Cumberlands	9 (no algebra) or 21 w/math emphasis	25	35
Western Kentucky University	9 (algebra required)	35	32.5 minimum
University of Louisville	21 w/math emphasis	36	36
Morehead State University	9	24	39
Murray State University	9 (no algebra) or 21 w/math emphasis	21-27	39
Kentucky State University	9	na	37
Northern Kentucky University	9 (no algebra) or 21 w/math emphasis	24	39
Eastern Kentucky University	9 (algebra required as general elective)	24	36
University of Kentucky	9 (no algebra)	24	36

Source: Staff compilation of university program requirements.

