The University of Texas at Austin
Charles A. Dana Center

Forging Relevant Mathematics Pathways in Arkansas

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> “We believe faculty in disciplines that do not require Calculus should not require students to take College Algebra. Instead, students should be required to take Quantitative Literacy or Introduction to Statistics, which are courses more relevant to their degree programs, future careers, and civic responsibilities.”

The Charles A. Dana Center invited the authors to share results from the *Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines*. The work presented here promotes the vision that all students should have equitable access to and the opportunity for success in rigorous mathematics pathways that are aligned and relevant to their future aspirations, propelling them to upward economic and social mobility in Arkansas.

This resource is offered to faculty who are reviewing mathematics requirements in their own departments. For more information on the Dana Center’s position on offering multiple mathematics pathways for students, go to https://dcmathpathways.org.

Historically, College Algebra has been the predominant general education (or core) requirement for all majors, including non-STEM (science, technology, engineering and mathematics) degrees, across public higher education institutions in Arkansas. With limited resources and low college-going and completion rates in the state (Arkansas Department of Higher Education, 2017), addressing student learning needs in a strategic and well-documented manner is crucial to Arkansas attainment initiatives. Specifically, research on identifying mathematics competencies required for each area of study is a vital component of addressing the attainment gap and completion challenges faced by the state’s public institutions of higher education.

In Arkansas—and nationwide—mathematics education continues to be the most significant area of skills deficit for students. Since 2007, the goal in Arkansas has been to identify mathematics competencies leading toward a targeted approach to improve mathematics knowledge and leverage student learning gains. The challenge remains to increase student retention and completion of degrees across programs and institutions throughout the state.

Departments should "replace traditional college algebra courses with courses stressing problem solving, mathematical modeling, descriptive statistics, and applications in the appropriate technical areas and thus, de-emphasize intricate algebraic manipulation."
(Ganter & Barker, 2004, p. 6)

Colleges and universities across the country are being challenged to provide all students entry-level mathematics courses that are relevant and focused on meeting the content needs of their intended majors. Since the early 2000s, the Mathematical Association of America (MAA) advocated that colleges and universities rethink the value and relevance of the course College Algebra as the required or general education (core) course for all entering students. In the MAA report from the Committee on Curriculum Renewal Across the First Two Years (CRAFTY), it concluded that the skills taught in College Algebra were not the skills required in disciplines outside of STEM. The MAA report in 2004, *Voices of the Partner Disciplines,* recommended that departments should "replace traditional college algebra courses with courses stressing problem solving, mathematical modeling, descriptive statistics, and applications in the appropriate technical areas and thus, de-emphasize intricate algebraic manipulation" (Ganter & Barker, 2004, p. 6).

In 2015, MAA released another report, *A Common Vision for Undergraduate Mathematical Sciences Programs in 2025* (Saxe & Braddy, 2015). The report boldly asserted, "*The status quo is unacceptable,*" and further challenged the mathematics community to:

- Upgrade curriculum,
- Articulate clear pathways between curricula driven by changes in K–12 and the first courses taken in college,
- Scale up the use of evidence-based pedagogical methods,
- Find ways to remove barriers facing students at critical transition points, and
- Establish stronger connections with other disciplines.

Through the leadership of the Arkansas Department of Higher Education (ADHE) and the task force established to participate in the Complete College America Alliance, much was accomplished in forming an alternate course to College Algebra. Now known as Quantitative Literacy (QL), this course is part of the Arkansas Course Transfer System (ACTS). QL, or a course with that content offered under a different title, is currently offered in all public four-year institutions and most two-year institutions in the state.

The Arkansas Department of Higher Education completed a two-year strategic planning process that included committees consisting of leaders from all of the state's public institutions of higher education. *Closing the Gap 2020: A Master Plan for Higher Education in Arkansas* (ADHE, 2015) was the outcome of this strategic planning process. This plan is a critical component to reaching the 2025 Arkansas goal of a 60% postsecondary attainment rate, increasing from the current estimate of 43.4%. The goal to close the attainment gap is clearly stated in the master plan: By 2020, the goal is to increase the number of postsecondary credentials by 40% over the 2013–2014 academic year levels; and to increase the number of certificates awarded to 16,880, associate degrees to 11,860, and bachelor's degrees to 19,520 (ADHE, 2015).

In response to the challenges observed by the strategic plan, the apparent need for implementation of alternate introductory mathematics courses for all majors, and overall student performance on entry-level mathematics courses, ADHE partnered with Arkansas Community Colleges (ACC) to apply for participation in the Mathematics Pathways to Completion (MPC) project of the Charles A. Dana Center at The University of Texas Austin. The MPC supports states in moving from a broad vision of mathematics pathways to institutional implementation. Arkansas was one of six states selected for this major effort. One of the first actions was to organize a leadership task force of mathematics faculty to assist ADHE in implementing the MPC project.

Arkansas Math Pathways Task Force

In 2015, the **Arkansas Math Pathways Task Force** (AMPT) was created, with membership comprising representatives of the mathematics departments from every public two-year and four-year higher education institution in the state. Charles Watson of the University of Central Arkansas and Valerie Martin of North Arkansas College served as co-chairs of the task force, representing the four-year and two-year institutions, respectively. Mike Leach, director of student success for Arkansas Community Colleges, along with representatives from ADHE, served as facilitators. Members of the Charles A. Dana Center at The University of Texas at Austin supported the task force as Mathematics Pathways to Completion consultants.

The goal of the Arkansas Math Pathways Task Force was to increase student success in higher education with the objective to establish multiple mathematics pathways for students by defining default mathematics courses aligned to programs of study. The charge was to write and then implement recommendations to meet this goal and objective. The task force considered recommendations from national organizations to explore different mathematics requirements for students. One such recommendation came from the Mathematical Association of America's 2004 curriculum guide:

> Unfortunately, there is often a serious mismatch between the original rationale for a college algebra requirement and the actual needs of students who take the course. A critically important task for mathematics sciences departments at institutions with college algebra requirements is to clarify the rationale for requirements, determine the needs of students, and ensure that department's courses are aligned with these findings. (MAA, 2004, p. 27)

The task force also considered two related goals from TPSE Math (Transforming Post-Secondary Education in Mathematics): Increase and accelerate student success in mathematics, and teach mathematics content and skills that will be of value to students in their lives and careers (TSPE Math, 2015).

The AMPT examined the **Dana Center Mathematics Pathways (DCMP) model**, which seeks to ensure that all students have equitable access to and the opportunity for success in rigorous mathematics pathways aligned and relevant to their future aspirations, propelling them to upward economic and social mobility. The first principle of the DCMP model includes enrolling students into "mathematics pathways aligned to their programs of study" (The Dana Center Mathematics Pathways, n.d.). For many students, a course in Quantitative Literacy or Introduction to Statistics would better prepare them for success in their degree programs and/or future career tracks.

One year after the first AMPT meeting, the task force published its report, **Arkansas Math Pathways Task Force Recommendations** (AMPT, 2017). In order to translate the eight recommendations into action, the task force was divided into four steering committees focused on Multiple Measures, Professional Development, ACTS Language, and Common Math Requirements. Membership in the subcommittees was voluntary. Each subcommittee included representation from two- and four-year institutions in Arkansas.

Common Math Requirements Steering Committee

The Common Math Requirements Steering Committee (Figure 1) was formed to address the task force's second recommendation, "Academic disciplines identify math competencies needed for specific programs of study and use competencies to recommend a common transferable math course requirement for each program of study" (AMPT, 2017). The committee's charge was to negotiate common mathematics pathways for all students majoring in a particular area regardless of the institution.

Figure 1. Common Math Requirements Steering Committee

Name	Title	Institution
Sharokh Abedi	Assistant Professor of Mathematics	University of Arkansas at Pine Bluff
Tracy Cobb	Mathematics Instructor	Southeast Arkansas College
Marvin Galloway	Dean of Mathematics, Physics and Engineering	Northwest Arkansas Community College
Melissa Hardeman	Senior Instructor	University of Arkansas at Little Rock
Sherri Hart	Mathematics Instructor	University of Arkansas Community College at Hope
Terry Hutson	Faculty	Southern Arkansas University Tech
Deborah Korth	Clinical Associate Professor; Director Fulbright Student Success	University of Arkansas
Mike Leach	Director of Center for Student Success	Arkansas Community Colleges
Larry Lord	Department Co-Chair, Mathematics, Physics and Engineering	Northwest Arkansas Community College
Valerie Martin	Department Chair, Math, Science and Agriculture	North Arkansas College
Laurie Walker	Assistant Professor of Mathematics	Harding University
Charles Watson	Associate Professor	University of Central Arkansas
Fred Worth	Professor of Mathematics and Computer Science	Henderson State University
Linus Yu*	Department Head, Mathematics	University of Arkansas–Fort Smith

*Steering Committee Chair

One of the main challenges to address was that many degree programs continue to require students to take College Algebra although these students are not Calculus bound. The task force believed that a different mathematics course—more relevant to these students' future careers and lives—would better serve students. The Common Math Requirements Steering Committee discussed how to work directly with faculty from non-STEM fields to determine the mathematical skills needed for students in each program of study. The committee explored which mathematical skills, taught in courses other than those taught in a traditional college algebra class, would be better suited for students in non-STEM programs of study.

Ultimately, the committee sought input from faculty in these disciplines by sending a survey to all chairs/heads from departments that offered majors that did not require students to take Calculus. The goal of the survey was to identify the mathematical skills and topics most relevant to students majoring in particular areas to ensure that students were learning the necessary mathematics. The survey results could then be used to make recommendations on which course(s) would best serve Arkansas students in a particular major.

In constructing the survey instrument, the steering committee first identified an all-inclusive list of mathematical skills addressed in common, lower level mathematics classes. These mathematical skills were arranged under main topics: nine main topics from College Algebra, seven main topics from Quantitative Literacy, and seven main topics from Introduction to Statistics. These main topics were organized alphabetically into one list.

Methodology

The *Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines* (Appendix A) was administered using Survey Monkey. The first question asked the respondent to enter the Classification of Instructional Programs (CIP) code to identify the non-STEM major. A link to a list of CIP codes was provided for quick reference. Brief questions asked for the respondent's identifiable information (e.g., name, email address, department affiliation, degree program). The survey then presented a comprehensive list of mathematics skills and sub-skills asking the respondent to check the main topics or mathematical skills they felt were important for students in their majors to comprehend. Space at the end of the survey allowed the respondent to list any relevant skills that were not included and to leave any comments or questions.

Two 4-year universities and one 2-year college in Arkansas were chosen to pilot the instrument. The intention was to have an expert in the field, preferably the department chair/head or designee, complete the survey. The ADHE senior associate director sent a request to the chief academic affairs officers (CAOs) at these three institutions to ask the chairs/heads from each department to complete the survey for each non-STEM degree program.

The results from the pilot survey were used to improve the instrument and methods for collecting responses. For example, a question for the name of a major was added to allow for more specificity (e.g., some majors offer both BA and BS degrees). The language in communications sent from the ADHE to the institutional CAOs requesting participation was also modified to reduce misunderstandings concerning which departments were considered STEM and which were not. Additional questions were incorporated from two-year colleges about transferability to four-year institutions. Overall, the pilot survey was considered a success with a larger response rate than expected. The results encouraged the Arkansas Math Task Force to implement the statewide survey.

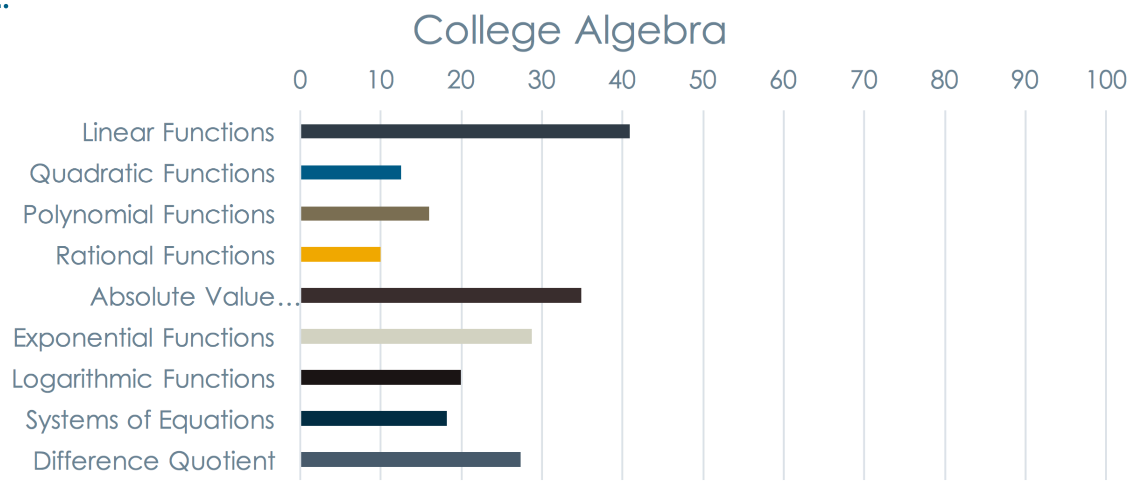
Findings

All public colleges and universities in Arkansas participated in the study. Survey responses—281 from four-year institutions and 90 from two-year institutions—were collected and are reported in aggregate (Appendix B). The respondents were chairs/heads or their designees of departments that grant degrees in arts, humanities, and social sciences. Of most interest in this study were the degree programs that did not require students to take Calculus.

Survey results from two- and four-year institutions were separated for the analysis. This separation was warranted due to reservations or perceived reservations of respondents from two-year schools on the position of faculty from four-year institutions. Two-year school respondents felt that their options were dependent on expectations of institutions where their students will transfer to complete degree requirements.

The following graphs represent the percentages of respondents from four-year institutions who felt that the particular main topic was important for students in their disciplines to study. The results are reported by the mathematics course in which these topics are typically taught. For example, 10% of the respondents identified rational functions as a topic important for their programs of study. This topic is typically taught in College Algebra, which is shown in Figure 2.

Figure 2.



The graph above shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in a College Algebra course. Linear functions were identified by 41% of the non-STEM programs as being needed for success in a degree program. All other topics in the traditional College Algebra course were identified as essential by less than 40% of the respondents.

Figure 3 shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in an Introduction to Statistics course. All of the topics identified as topics addressed in Introduction to Statistics were selected by 30% or more of the respondents. Thus, more respondents found the topics addressed in Introduction to Statistics to be relevant compared to those topics listed in College Algebra.

Figure 3.

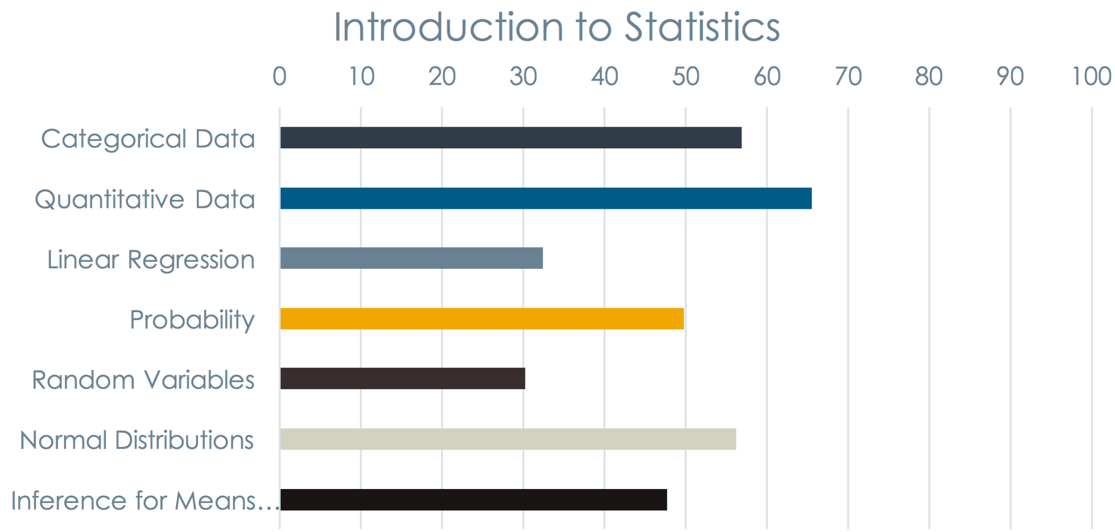
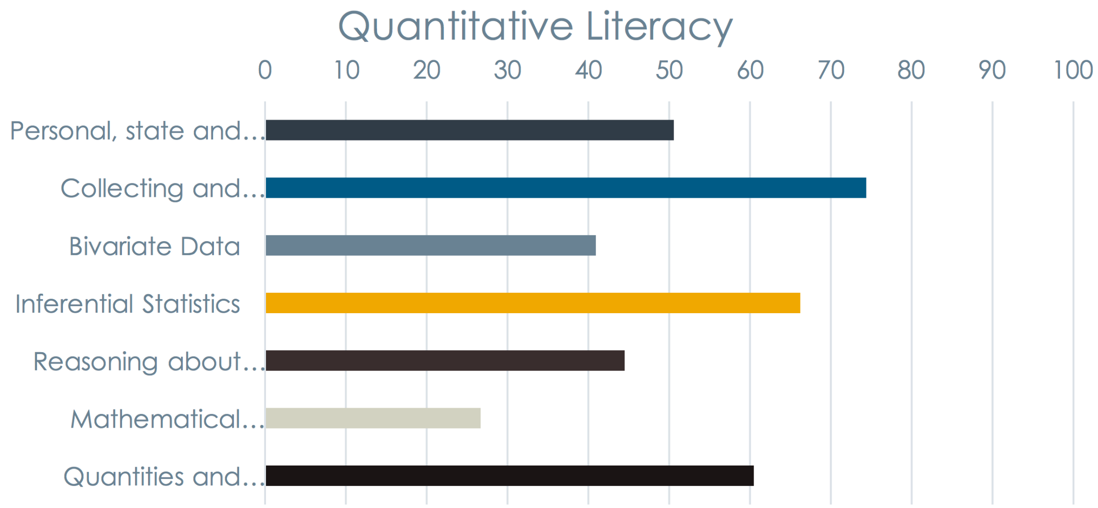


Figure 4 shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in a Quantitative Literacy course. All topics with only one exception (Mathematical Modeling) were selected by over 40% of the respondents as essential to non-STEM majors. Thus, more respondents found the topics addressed in Quantitative Literacy to be relevant compared to those topics listed in College Algebra.

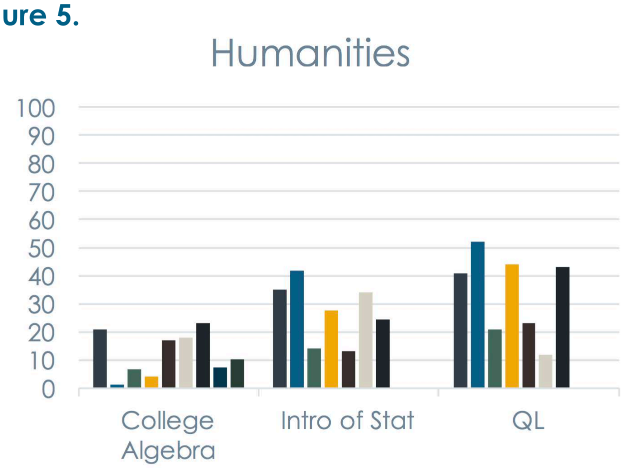
Figure 4.



Most of the chairs/heads who responded to the survey indicated that, in general, the topics taught in Introduction to Statistics and Quantitative Literacy were more important to their students/disciplines than topics taught in College Algebra. All of the topics listed as part of the Introduction to Statistics were reported as necessary by more than 30% of the respondents. Five out of seven of those topics were reported as important by more than 50% of the respondents. All of the topics regarded as part of the Quantitative Literacy curriculum were reported as necessary by more than 25% of the respondents. "Collecting and describing data" had the highest respondent rate (74%). The most popular topic in College Algebra was linear functions (41%). The second and the third were absolute value functions and exponential functions. Most of the topics in College Algebra were reported as necessary by less than 30% of respondents.

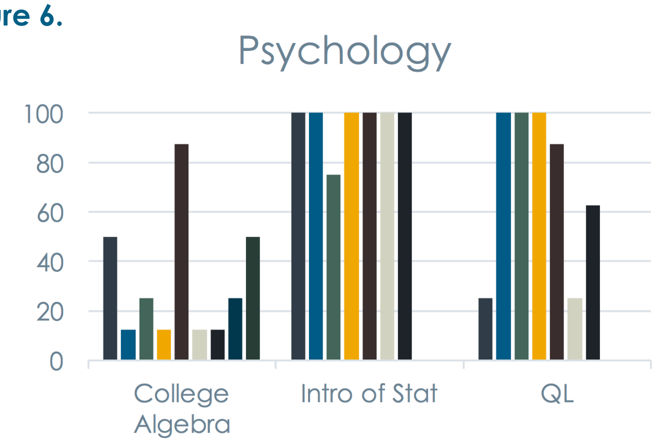
Figures 5–8 show the responses of the department chairs/heads who teach in the humanities, followed by the responses from the departmental leadership from the most popular majors statewide: psychology, criminal justice, and nursing. Again, topics addressed in the Quantitative Literacy and Introduction to Statistics Courses were more often deemed essential by the respondents compared to the topics listed in the College Algebra course.

Figure 5.



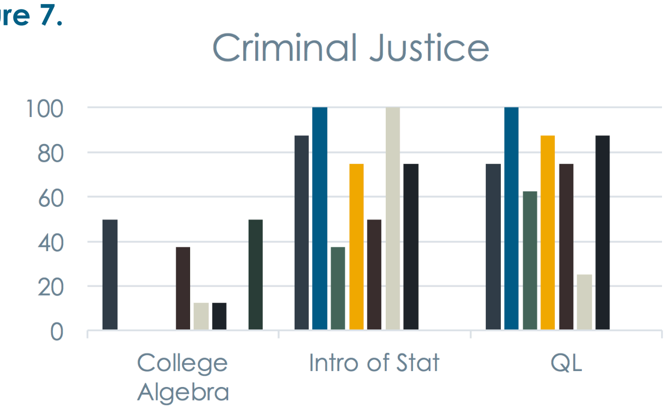
Department chairs/head from the humanities did not view many of the mathematics topics listed as relevant for their disciplines. However, at least 40% of respondents listed four topics in Quantitative Literacy and one topic in Introduction to Statistics as relevant to their disciplines.

Figure 6.



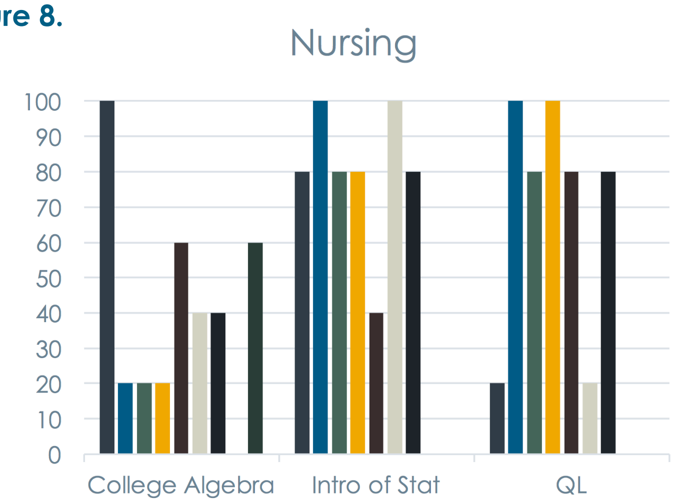
All department chairs/heads in psychology who responded to the survey agreed that six of the seven topics contained in Introduction to Statistics are important for their majors. They also showed strong support for four topics listed in Quantitative Literacy. The majority of the psychology chairs/heads who responded to the survey did not indicate that the topics listed in College Algebra were as important except for absolute value functions.

Figure 7.



The chairs/heads of criminal justice departments most often listed the topics contained in Introduction to Statistics and Quantitative Literacy as most important to their students. Their responses did not show strong support for the topics listed in College Algebra. In fact, there were four topics in College Algebra that none of criminal justice chairs/heads listed as necessary for their students to study.

Figure 8.



The nursing department chairs/heads identified the most topics from Introduction to Statistics as important for their fields as well as the top three topics from College Algebra: linear functions, absolute value functions, and the difference quotient. The only topic in College Algebra not selected by any participant was systems of equations.

Recommendation

Based on the recommendations from American Mathematical Association of Two-Year Colleges (AMATYC), American Mathematical Society (AMS), the American Statistical Association (ASA), Mathematical Association of America (MAA), and Society for Industrial and Applied Mathematics (SIAM) and the responses from the chairs/heads of the departments surveyed across the state, the Arkansas Math Pathways Task Force believes faculty in disciplines that do not require Calculus should not require students to take College Algebra. Instead, students should be expected to take Quantitative Literacy or Introduction to Statistics, which are courses more relevant to their degree programs, future careers, and civic responsibilities.

Quantitative Literacy and Introduction to Statistics are rigorous courses in which the topics addressed more closely align with the topics that most department leaders in Arkansas, as well as national leaders in mathematics higher education, believe are relevant to their students. Topics in these courses are not "easier" than those taught in College Algebra; they are simply more relevant to the students' programs of study. The recommendation to examine mathematics competencies by program of study is not intended to diminish rigor, but to address relevance.

If researchers wish to replicate this study, it is recommended that all academic departments be surveyed at each institution to avoid the confusion over which departments are identified as STEM. To assist with identifying if a program of study should be considered a STEM program or not, add a question on the survey that allows respondents to indicate whether a calculus course is required as part of the degree program.

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Appendix A: Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines

ADHE is conducting this survey in cooperation with the Arkansas Math Pathways Task Force, a group of math faculty from every public two-year and four-year college in Arkansas. ADHE's ultimate goal is to better align the math skills taught to students and the math skills students need to be successful in their chosen majors. Improving the transferability of math courses also is an important goal. To help achieve these goals, every public two-year and four-year college in the state is being asked to complete this survey.

The purpose of this survey is to understand the mathematical skills needed in specific majors so mathematics departments can better prepare students for their future studies. There are twenty-seven math competencies in this survey. Please only complete one survey for each non-STEM major, and click only those math skills that are needed for each non-STEM major.

Note to two-year colleges: Only complete a survey for each of your transfer programs, and only choose those math skills needed for completing a two-year transfer degree.

Please complete all surveys by April 28, 2017.

If you have any questions or need further clarification on the math skills listed, please contact the Arkansas Math Pathways Task Force representative on your campus (see the table below) or Dr. Linus Yu (linus.yu@uafs.edu).

Four-Year College	
Arkansas State University Jonesboro	Lisa Rice
Arkansas Tech University	Kristi Brown David Underwood
Southern Arkansas University	Caroline Neeley
University of Arkansas - Fort Smith	Linus Yu Emily Foss
University of Arkansas at Little Rock	Ann Childers Melissa Hardeman
University of Arkansas at Pine Bluff	Sharokh Abedi
University of Arkansas, Fayetteville	Deborah Korth
University of Central Arkansas	Charles Watson
Harding University	Laurie Walker
University of the Ozarks	Matt Myers

Two-Year College	
Arkansas Northeastern College	Deborah Parker
Arkansas State University Beebe	Richard Counts
Arkansas State University Mid-South	Stephanie Krehl
Arkansas State University Mountain Home	David Bendler
Arkansas State University Newport	Stephanie Wilson
Black River Technical College	Jessica Stout
College of the Ouachitas	Sean Elkin
Cossatot Community College of the University of Arkansas	Crystal Sims
East Arkansas Community College	Joana Lawson Jo Patterson
National Park College	Amy Benzi David Hughes Brian Theroux Karla Williams
North Arkansas College	Sherry Jennings Annette Robinson Valarie Martin
Northwest Arkansas Community College	Marvin Galloway Larry Lord
Ozarka College	Jed O'Brien
Phillips Community College of the University of Arkansas	E. Gary Torelli Brian Zimmerman
Pulaski Technical College	Denise Hammett
Rich Mountain Community College	Susan Tipton
South Arkansas Community College	Vernita Morgan
Southeast Arkansas College	Tracy Cobb
Southern Arkansas University Tech	Terry Hutson Teresa McLeane
University of Arkansas Community College at Batesville	Douglas Muse Yuee Chen
University of Arkansas Community College at Hope	Melanie Dillard Sherri Hart
University of Arkansas Community College at Morrilton	Nanette Berry

Please indicate the title and 6-digit CIP code of the *non-STEM* major for this survey submission. (Please submit a separate survey for each major, and please only submit one survey for each major. See the list of 6-digit CIP codes at 6 digit CIP code link.)

What is the name of the major? (For example, BA Psychology or BS Sociology)
What is your name?
What is your contact email?
What is the name of your institution?

Please click only those math skills that are needed for the major. If certain sub-skills listed are NOT needed, please provide that feedback in the comment section at the end of the survey.

❑	Absolute Value Functions 1. Definition of absolute value and absolute value functions. 2. Graph of absolute value functions. 3. Solving absolute value equations. 4. Solving absolute value inequalities.
❑	Bivariate Data 1. Represent bivariate quantitative data using a scatter plot and describe how the variables might be related. 2. Compute and interpret a correlation coefficient given bivariate numerical data. 3. Distinguish between correlation and causation and between conspiracy and coincidence.
❑	Categorical Data 1. Summarize categorical data by constructing frequency tables and relative frequency tables. 2. Display categorical data with bar graphs. 3. Exploring two categorical variables by analyzing contingency tables.
❑	Collecting and Describing Data 1. Represent data graphically using a display appropriate for the data type. 2. Use statistics appropriate to the shape of data distributions to compare center and spread. 3. Interpret differences in shape, center and spread in the context of the data sets, accounting for possible extreme data points. 4. When appropriate, use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages.
❑	Collecting Data 1. Distinguish between an observational study and a statistical experiment. 2. Describe the purpose of random selection in an observational study and the purpose of random assignment in a statistical experiment. 3. Understand the types of conclusions that can be drawn from an observational study and from an experiment. 4. Describe a method for selecting a random sample from a population.

❑	Describing Data Distributions 1. Summarize univariate data using an appropriate graphical display. 2. Describe a distribution of numerical data. 3. Summarize univariate data using appropriate numerical summary measures. 4. Find the five number summary and create a boxplot for a given numerical data set. 5. Summarize bivariate numerical data graphically using a scatterplot. 6. Use the correlation coefficient to describe the strength and direction of a linear relationship between two numerical variables. 7. Display time series data using a time series plot. 8. Describe change over time given a time series plot. 9. Critique graphical displays in the media.
❑	Difference Quotient 1. Average rate of change. 2. Difference quotient.
❑	Exponential Functions 1. Definition of exponential functions. 2. Graph of exponential functions. 3. Solving exponential equations.
❑	Inference for Means and Proportions 1. Describe characteristics of the sampling distribution of a sample mean and of a sample proportion. 2. Define and apply the central limit theorem for random samples. 3. Calculate a confidence interval for a population mean given a random sample. 4. Interpret a confidence interval for a population mean in context and interpret confidence level. 5. Carry out a test of hypotheses about a population mean given a random sample. 6. Calculate and interpret a confidence interval for a population proportion. 7. Carry out a test of hypotheses about a population proportion. 8. Calculate and interpret a confidence interval for the difference in two population means or two population proportions. 9. Carry out a test of hypotheses about the difference in two population means or two population proportions.
❑	Inferential Statistics 1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. 2. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. 3. Evaluate reports or print media articles based on statistical data.

❑	Linear Functions 1. Definition of linear functions. 2. Slope-intercept form and point-slope form. 3. Parallel and perpendicular lines. 4. Piecewise functions. 5. Solving linear equations. 6. Solving linear inequalities.
❑	Linear Regression 1. Construct a scatterplot of bivariate numerical data. 2. Calculate a correlation coefficient. 3. Calculate the least squares regression line of best fit. 4. Interpret the slope and y-intercept (if appropriate) of the least squares regression line in context.
❑	Logarithmic Functions 1. Definition of logarithmic function. 2. Properties of logarithm. 3. Graph of logarithm functions. 4. Solving logarithm equations. 5. Using logarithm to solve exponential equations.

Please click only those math skills that are needed for the major.

❑	Mathematical Modeling 1. Use function notation, understand functions as processes, and interpret statements that use function notation in terms of a context. 2. Construct graphs and tables that model changing quantities and interpret key features in terms of the quantities. 3. Interpret the slope and the intercept of a linear model in the context of the data. 4. Graph linear and exponential functions and identify critical points. 5. Compute and interpret the correlation coefficient of a linear fit. 6. Distinguish between situations that can be modeled with linear functions and those modeled with exponential functions. 7. Use linear and exponential functions to model contextual situations such as costs and growth of savings accounts.
❑	Modeling with Probability 1. Understand probability as a measure of the likelihood that an event will occur. 2. Interpret probabilities in context. 3. Use data in a two-way table to calculate probabilities. 4. Calculate and interpret expected value in simple contexts.

❑	Normal Distributions 1. Describe characteristics of a normal distribution and calculate and interpret a z-score using the mean and standard deviation of the normal distribution. 2. Calculate areas under a normal curve and interpret these areas as probabilities in context. 3. Approximate population percentages using a normal distribution.
❑	Personal, State and National Finance 1. Explore essentials of creating a family/personal budget. 2. Understand the difference between simple and compound interest and their effects on savings and expenditures. 3. Explore saving and investment accounts. 4. Explore loan payments, credit card accounts and mortgages.
❑	Polynomial Functions 1. Definition of polynomial functions. 2. Characteristics of polynomial functions: degree, zeros, multiplicity, turning points. 3. Long division and/or synthetic division.
❑	Probability 1. Define sample space and events. 2. Calculate probabilities of unions, intersections and complements of events. 3. Discuss the law of large numbers vs. law of averages myth. 4. Estimate probabilities empirically and interpret probabilities and long-run relative frequencies. 5. Distinguish between independent events and dependent events. 6. Use data in two-way tables to calculate probabilities, including conditional probabilities.
❑	Quadratic Functions 1. Definition of quadratic functions 2. Graphing quadratic functions: vertex, intercepts, maximum or minimum 3. Solving quadratic equations: factoring, quadratic formula, graphically. 4. Solving quadratic inequalities.
❑	Quantitative Data 1. Create visual displays of quantitative data. 2. Find the five-number summary for a given data set and create a boxplot to represent the data set. 3. Calculate measures of central tendency for numerical data, including mean, median, mode. 4. Calculate measures of spread for numerical data, including range, interquartile range, standard deviation 5. Describe the overall shape of a distribution of data and identify any outliers in the data set.

❑	Quantities and measurement 1. Understand the use of units, thinking of numbers as adjectives. 2. Study multiple ways of comparing quantities including the use of indices, e. g. the consumer price index and its relationship to the changing value of the dollar. 3. Investigate ways of finding exact and approximate areas and volumes of geometric and irregular shapes.
❑	Random Variables 1. Distinguish between discrete and continuous random variables. 2. Understand that a probability distribution describes the long-run behavior of a random variable. 3. Calculate expected value and standard deviation of a discrete variable.
❑	Rational Functions 1. Definition of Rational functions. 2. Graph of rational functions (including asymptotes). 3. Solving rational equations. 4. Solving rational inequalities.
❑	Reasoning about Probability 1. Describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersections, or complements of other events. 2. Calculate and interpret probabilities of the union and intersection of independent and dependent events. 3. Understand and determine conditional probabilities, applying in cases such as the false positive paradox. 4. Use permutations and combinations to compute probabilities of compound events and solve problems. 5. Find the expected payoff for a game of chance. 6. Analyze risk in health situations and understand the difference between absolute changes in risk and relative changes in risk.
❑	Statistical Inference 1. Understand the concept of sample-to-sample variability and describe how this understanding relates to statistical inference. 2. Explain the meaning of margin of error and interpret margin of error in context. 3. Understand the concept of a confidence interval estimate and interpret confidence intervals as an interval of plausible values for a population characteristic. 4. Interpret a confidence interval in context and interpret confidence level. 5. Interpret a P-value in context and use a P-value to reach a conclusion in a hypothesis testing context.
❑	Systems of Equations 1. Solving system of equations with application.

Please list any other math skills that might be needed but were not listed.

Do you have any other comments, questions, or concerns?

Appendix B: Summary Data from the Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines

Respondents to the *Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines* comprised all chairs, department heads, or appropriate designees representing departments defined as "non-STEM" from every public college in Arkansas.

The table below contains the percentages of respondents in the study who felt that the indicated mathematical topic was important for the students studying in their discipline. In this report, the topics are placed under the courses in which the topics are normally taught.

College Algebra			
Mathematical Topic	**4-year only**	**2-year only**	**Overall**
Linear Functions	41%	63%	45%
Quadratic Functions	12%	36%	18%
Polynomial Functions	16%	28%	19%
Rational Functions	10%	17%	12%
Absolute Value Functions	35%	42%	37%
Exponential Functions	29%	53%	35%
Logarithmic Functions	20%	29%	22%
Systems of Equations	18%	36%	22%
Difference Quotient	27%	38%	30%
Introduction to Statistics			
Mathematical Topic	**4-year only**	**2-year only**	**Overall**
Categorical Data	57%	66%	59%
Quantitative Data	65%	59%	64%
Linear Regression	32%	22%	30%
Probability	50%	50%	50%
Random Variables	30%	28%	30%
Normal Distributions	56%	34%	51%
Inference for Means and Proportions	48%	56%	50%
Quantitative Literacy			
Mathematical Topic	**4-year only**	**2-year only**	**Overall**
Personal, state and national finance	51%	69%	55%
Collecting and Describing Data	74%	69%	73%
Bivariate Data	41%	58%	45%
Inferential Statistics	66%	53%	63%
Reasoning about Probability	44%	49%	46%
Mathematical modeling	27%	61%	35%
Quantities and measurement	61%	67%	62%