Learning Outcomes for Mathematics and Statistics Classes

Approved by the Department of Mathematics and Statistics on XXX
Up to date for the 2022-2023 Academic Year

Introduction

We begin with the Learning Outcomes for our LOPER 4 General Studies classes, followed by our Learning Outcomes for our two Experiential Learning classes. After that, we list the Learning Outcomes for our MATH classes in numerical order, followed by our STAT classes also in numerical order.

Learning Outcomes for LOPER 4 General Studies Mathematics and Statistics Classes

Our General Studies classes are **MATH 102** (College Algebra), **MATH 103** (Plane Trigonometry), **MATH 106** (Mathematics for Liberal Arts), **MATH 115** (Calculus I with Analytic Geometry), **MATH 120** (Finite Mathematics), **MATH 123** (Applied Calculus I), **MATH 230** (Math for Elementary Teachers I), **STAT 235** (Introduction to Statistics for Social Sciences), and **STAT 241** (Elementary Statistics). The learning outcomes for LOPER 4 classes are

1. Can describe problems using mathematical, statistical, or programming language.
2. Can solve problems using mathematical, statistical, or programming techniques.
3. Can construct logical arguments using mathematical, statistical, or programming concepts.
4. Can interpret and express numerical data or graphical information using mathematical, statistical, or programming concepts and methods.

Learning Outcomes for Experiential Learning Mathematics and Statistics Classes

Our Experiential Learning classes are: **MATH 300** (Tutoring in Mathematics) and **MATH 390** (Research Experience in Mathematics). The learning outcomes for our Experiential Learning classes are

1. Student reflects critically on their research experience, describing the experience including reactions, observations, and thoughts on research problems in mathematics.
2. Student reflects critically on their research experience, articulating connections between experiential learning in mathematical research and their coursework in mathematics.
3. Student communicates mathematical concepts, ideas, methods, and results effectively in both oral and written form.
4. Student demonstrates dispositions appropriate to mathematics and possibly other related areas (e.g., physics, computer sciences, etc.).
5. Student demonstrates mastery of the practical use of mathematical skills in solving research problems.

MATH 90, Elementary Algebra

On completion of this course, students will be able to

1. Translate written sentences to algebraic expressions and solve applied problems.
2. Understand arithmetic operations on whole numbers, fractions, decimals, and percents.
3. Simplify algebraic expressions and solve linear and quadratic equations.

   (4) Apply factoring techniques for quadratics and for the prime factorization of whole numbers.

   (5) Identify, write, and graph linear equations and introduce the quadratic.

   (6) Apply algebraic operations to polynomials and rational expressions.

Learning Outcomes for MATH 101 (Intermediate Algebra)

On completion of this course, students will be able to

   (1) Solve linear equations and inequalities.

   (2) Set up and solve applications with linear equations.

   (3) Analyze functions including evaluating, finding domain, and graphing by translation.

   (4) Apply operations to polynomial functions and rational functions.

   (5) Factor polynomials of degree greater than two.

   (6) Simplify rational functions and solve rational inequalities.

   (7) Use the properties of exponents to simplify expressions.

   (8) Solve radical equations.

   (9) Analyze quadratic functions including finding the vertex and axis of symmetry.

 (10) Factor quadratic functions by completing the square and the quadratic formula.

 (11) Graph quadratic functions.

MATH 104, Concepts in Mathematics and Statistics

On completion of this course, students will be able to

   (1) Identify, write, and graph linear functions.

   (2) Write and graph quadratic functions.

   (3) Solve linear and quadratic equations and inequalities.

   (4) Solve two-variable systems of linear equations.

   (5) Determine probabilities for independent events.

   (6) Use the multiplication principle, permutations, and combinations.

   (7) Use measures of center including mean, median, and mode.

   (8) Use measures of variation including standard deviation, range, and variance.

   (9) Describe distributions and create box plots.

MATH 202, Calculus II with Analytic Geometry

On completion of this course, students will be able to

   (1) use definite integrals to solve problems involving volume, arc length, surface area, work, and center of mass.

   (2) use integration by parts, trigonometric substitution, and partial fractions to evaluate definite and indefinite integrals.

   (3) apply the concepts of limits, convergence, and divergence to evaluate improper integrals.

   (4) determine convergence or divergence of sequences and series.

   (5) use Taylor and MacLaurin series to represent functions and integrate functions.

   (6) use parametrizations and polar coordinates to find areas and arc lengths.

MATH 250, Foundations of Math

On completion of this course, students will

(1) gain an understanding of naïve set theory.

(2) gain an understanding of symbolic logic, quantifiers, and functions.

(3) gain an understanding of direct proofs, proofs by contradiction, proofs by contrapositive, and proofs by induction.

(4) gain the ability to read and understand mathematical proofs.

(5) gain the problem solving skills that are needed to create a mathematical proof.

MATH 251, Inquiry and Proof in 9–12 Mathematics

On completion of this course, students will be able to

(1) Articulate and utilize mathematical practices essential for 9–12 mathematics.

(2) Articulate the roles proof can play in secondary mathematics instruction.

(3) Engage in mathematical inquiry using technological and mathematical tools.

(4) Articulate mathematical arguments with precise mathematical language and symbols.

(5) Communicate technical mathematical justifications in a manner appropriate for secondary students.

(6) Determine how essential understanding of proof is embedded across mathematical content.

MATH 260, Calculus III

On completion of this course, students will

(1) be able to use vectors to solve geometric problems and basic engineering statics problems.

(2) understand the concept of partial derivatives and limits of multivariable functions.

(3) understand the concept of a parameterized curve and understand the concept of curvature.

(4) be able to use partial derivatives to solve multivariable optimization problems.

(5) understand the concept of a line integral and apply it to basic physics problems involving energy and work.

(6) be able to set up and evaluate multiple integrals using Cartesian, polar, and spherical coordinates to find volumes, surface areas, centroids, and moments of inertia.

(7) understand the concepts of the vector divergence, gradient, and curl in three-dimensional space.

(8) understand the Green theorem and the Divergence theorem and be able to apply these theorems to problems involving surface and line integrals.

MATH 270, Methods in Middle and High School Mathematics Teaching I

On completion of this course, students will be able to

(1) Thoroughly describe what is meant by "doing, teaching, and learning" mathematics in their own words and with the support of mathematics educational research.

(2) Explain and provide real-life examples of the eight research-based mathematics teaching practices.

(3) Identify and begin creating opportunities for high-quality instruction that includes mathematical discourse, productive struggle, purposeful questioning, and the connecting of multiple representations.

(4) Articulate the essential mathematical concepts of 6–12 mathematics curriculum in regard to number, algebra/functions, statistics/probability, and geometry/measurement.

(5) Explain the organization and benefits of the NCTM Standards, the Common Core State Standards, and the Nebraska State Standards.

(6) Explain the history and current trends in mathematics education.

(7) Define NCTM and NATM, explain membership benefits associated with each organization, and articulate the importance of professional affiliations.

(8) Build upon foundational understanding of mathematics education and research-based mathematics teaching.

(9) Be reflective of your own learning and realize how his/her own understanding influences student learning.

MATH 271, Field Experience in Middle and High School Mathematics I

On completion of this course, students will be able to

(1) Identify research-based mathematics teaching practices that are included in the classroom, as well as how they could be incorporated.

(2) Engage 6–12 students in developmentally appropriate mathematical activities.

(3) Work with a diverse range of students individually, in small groups, and in large class settings.

(4) Plan, facilitate, and reflect upon mathematical tasks that promote reasoning and sense making.

(5) Collect and analyze data to determine if 6–12 students have built new knowledge.

(6) Meet expectations of all Teacher Education Dispositions, including

   (a) Demonstrate effective oral communication skills
   (b) Demonstrate effective written communication skills
   (c) Demonstrate professionalism
   (d) Demonstrate a positive and enthusiastic attitude
   (e) Demonstrate preparedness in teaching and learning
   (f) Exhibits an appreciation of and value for cultural and academic diversity
   (g) Collaborates effectively with stakeholders
   (h) Demonstrates self-regulated learner behaviors/takes initiative
   (i) Exhibits the social and emotional intelligence to promote personal and educational goals/stability

MATH 280, Linear Algebra

On completion of this course, students will

(1) Be able to solve systems of linear equations using multiple methods, including row reduction to echelon form, row reduction to echelon form, and multiplication by a matrix inverse.

(2) Be able to carry out matrix operations, including finding sums, products, transposes, inverses and determinants of matrices.

(3) Demonstrate an understanding of the concepts of vector space and subspace.

(4) Demonstrate an understanding of linear independence, span, and basis.

(5) Be able to determine eigenvalues and eigenvectors and solve eigenvalue problems.

(6) Be able to apply the principles of matrix algebra to linear transformations.

(7) Demonstrate an understanding of inner products and their associated norms.

MATH 305, Differential Equations

On completion of this class, students will

(1) Know the basic methods for solving first order differential equations (ODEs).

(2) Be able to set up and solve applied problems involving first order ODEs.

(3) Know the basic methods for solving second order ODEs.

(4) Know the basic methods for solving systems of first order ODEs.

(5) Be able to solve initial value problems for first and second order ODEs and for systems of ODEs.

MATH 310, College Geometry

On completion of this course, students will be able to

(1) understand the basic definitions, axioms, and important theorems in neutral geometry.

(2) compare Euclidean geometry, hyperbolic geometry, and elliptical geometry.

(3) use the axiomatic or transformational approach to prove theorems in neutral/Euclidean geometry.

(4) use interactive geometry software for constructions in plane geometry, and explain geometric concepts and results in concrete models.

MATH 330, Math for Elementary Teachers II

On completion of this course, students will be able to

(1) Explain and perform operations with fractions and decimals.

(2) Apply understanding of ratios, percentages, and proportions to real-life situations.

(3) Identify, categorize, compare and contrast various shapes and solids.

(4) Determine the area, surface area, and volume of two and three-dimensional objects.

(5) Approach mathematics problems using a variety of methods.

(6) Explain mathematical concepts to students at their level of understanding.

MATH 350, Abstract Algebra

On completion of this course

(1) Students will be familiar with and able to grasp algebraic mathematical structures.

(2) Students will be able to understand the concept of equivalence relation by applying different examples to the definition.

(3) Students will be able to rigorously prove theorems in all the standard ways including using mathematical induction, some other direct method, and using proof by contradiction.

(4) Students will have a firm grasp on Group theory including cyclic groups, permutation groups, homomorphisms, normal subgroups, and simple groups, with some real world applications of groups acting on a set.

(5) Students will have an understanding of the differences between rings, integral domains, unique factorization domains, Euclidean domains, and fields.

(6) Students will comprehend correct proofs of formal statements and be able to formulate some of the proofs clearly and concisely.

MATH 365, Complex Analysis

On completion of this course, students will

(1) be able to represent complex numbers algebraically and geometrically.

(2) be able to use the definition of the limit to prove that a function has a limit.

(3) be able to find derivatives of complex valued functions from the limit definition.

(4) understand the connection between the complex exponential and the trigonometric functions and be able to prove trigonometric identities using these connections.

(5) be able to use the Cauchy-Riemann equations to determine if a function is analytic.

(6) be able to represent functions using Laurent and power series and be able to find function residues, poles, and pole order.

(7) be able to evaluate contour integrals using residues.

(8) understand the Cauchy integral formula and its consequences, including the fundamental theorem of algebra.

MATH 399, Internship

The Learning Outcomes are the following:

(1) Write a two page description of the activities of the internship.

(2) Give three examples in which topics you learned in undergraduate mathematics courses came up and/or were used in an activity of the internship. Describe and discuss. If three examples cannot be given, list one, or two, if possible, and say that there were less than three.

(3) Give any examples of mathematical topics that came up and/or were used in an activity of the internship that you had not seen before. Describe and discuss.

(4) Describe two jobs and/or careers for which the experience of the internship made you more qualified than you were before.

(5) Fill in the blank: I would have been better prepared for the internship if I had previously _____.

(6) Fill in the blank: My next step(s) in developing a career path is(are) _____.

MATH 400, History of Mathematics

On completion of this course, students will

(1) understand the progression of mathematics through history.

(2) understand the history of a variety of mathematical topics.

(3) gain an understanding of several mathematicians through history.

MATH 404, Theory of Numbers

On completion of this course, students will be able to

(1) explain the concepts of divisibility, prime number, and congruence.
(2) calculate the greatest common divisor using the Euclidean algorithm and the prime factorization.
(3) solve linear congruence and quadratic congruence equations.
(4) understand Wilson's Theorem and Fermat's Little Theorem.
(5) compute Euler's torsion function and other important multiplicative functions.
(6) use primitive roots and index arithmetic to solve higher-order congruence equations.
(7) solve linear Diophantine equations and find primitive Pythagorean triples.
(8) understand how rational numbers are related to repeating decimals and continued fractions.

MATH 413, Discrete Mathematics

On completion of MATH 413, students will

(1) gain an understanding of counting principles and how to apply them.
(2) gain an understanding of discrete structures and how to use and analyze them, including induction, recursion, and probabilistic methods.

MATH 420, Numerical Analysis

On completion of this course, students will

(1) understand IEEE arithmetic and know the rules for accurate computation.
(2) understand the concepts of linear and quadratic convergence and use these concepts to analyze the efficiency of an algorithm.
(3) develop an understanding of the algorithms for solving linear and nonlinear equations, interpolation, quadrature, least squares methods, and solution of differential equations.
(4) be able to use a programming language and graphical tools to solve problems numerically.

MATH 430, Middle School Mathematics

On completion of this course, students will be able to

(1) Conceptualize the real number system, including rational and irrational numbers.
(2) Explain algebraic procedures (i.e. solving equations/inequalities, laws of exponents).
(3) Simplify exponential and radical expressions.
(4) Apply transformation properties of congruent and similar figures.
(5) Identify and interpret graphs and functions.
(6) Compare and contrast different types of functions.
(7) Apply the Pythagorean Theorem to variety of situations.
(8) Use the coordinate plane to solve problems and display mathematics.
(9) Calculate, display, and interpret statistical measures.
(10) Perform probability simulations and interpret results.

(11) Approach mathematical problems using a variety of methods.

(12) Use various teaching models and techniques of curriculum delivery including effective questioning, cooperative learning, inquiry, and constructivist learning.

(13) Explain mathematical concepts to students at their level of understanding.

(14) Be reflective of your own learning and realize how his/her own understanding influences student learning.

MATH 445, Actuarial Science Seminar

This course will help prepare the student to take the Actuarial exam P1.

MATH 460, Advanced Calculus I

On completion of this class, students will

(1) be able to prove basic propositions that involve the fundamentals of point set topology, including the concepts of open sets, closed sets, boundary points, and limit points.

(2) be able to prove basic propositions that involve the concept of the infimum and supremum.

(3) demonstrate competence with basic properties of sequences including determining convergence and proving results involving the sum, difference, product, and quotient of sequences.

(4) be able to use the definitions of continuity, uniform continuity, the limit, and the derivative to prove basic propositions involving these concepts as well as be able to prove facts about specific functions.

(5) demonstrate the ability to use the Mean Value Theorem to prove theorems.

(6) be able to define and evaluate the lower, upper, and general Riemann sums.

(7) demonstrate a solid understanding of the fundamental theorem of calculus.

MATH 465, Advanced Study in 9–12 Mathematics

On completion of this course, students will be able to

(1) Connect higher level content knowledge to essential content in secondary mathematics.

(2) Explain the impact of higher-level mathematical content knowledge on their teaching of high school students.

(3) Articulate and utilize mathematical practices essential for 9–12 mathematics.

(4) Describe essential understandings for 9–12 students in number theory, algebra/functions, statistics, probability, and calculus.

(5) Demonstrate the interconnectedness of mathematics among mathematical ideas.

(6) Utilize technological tools to explore essential mathematical content in number/quantity, algebra, statistics/probability, and calculus.

MATH 470, Methods in Middle and High School Mathematics Teaching II

On completion of this course, students will be able to

(1) Develop effective unit and lessons that support district, state and national standards and are developmentally appropriate.

(2) Incorporate various forms of communication and connections (including within the subject area, to other disciplines and to real life) into lessons.

(3) Diagnose and assess student performance in a variety of ways, including formative, summative, open ended, and performance assessments.

(4) Address student diversity and various learning needs in lessons and units.

(5) Use teaching methods and techniques of curriculum delivery including effective questioning, co-operative learning, inquiry, technology, and problem solving.

(6) Incorporate various classroom organization and management techniques when teaching students.

(7) Develop mathematical experiences for students, which will lead to positive dispositions toward math.

(8) Explain the organization and benefits of the NCTM Standards, the Common Core State Standards, Nebraska State Standards, and current trends in mathematics education.

(9) Define NCTM and NATM, and explain membership benefits associated with each organization, and articulate the importance of professional affiliations.

(10) Be reflective of your own learning and realize how his/her own understanding influences student learning.

MATH 471, Field Experience in Middle and High School Mathematics II

On completion of this course, students will

(1) Utilize research-based mathematics teaching practices in the classroom.

(2) Engage 6–12 students in developmentally appropriate mathematics lessons.

(3) Incorporate technology and tools into the 6–12 class in order to enhance mathematical understanding.

(4) Work with a diverse range of students individually, in small groups, and in large class settings.

(5) Plan, facilitate, and reflect upon mathematics lessons that promote reasoning and sense making.

(6) Collect and analyze data to determine if 6–12 students have built new knowledge.

(7) Collaborate with colleagues, other school professionals, families, and stakeholders.

(8) Continue to develop as a reflective practitioner.

(9) Meet expectations of all Teacher Education Dispositions, including

   (a) Demonstrate effective oral communication skills
   (b) Demonstrate effective written communication skills
   (c) Demonstrate professionalism
   (d) Demonstrate a positive and enthusiastic attitude
   (e) Demonstrate preparedness in teaching and learning
   (f) Exhibits an appreciation of and value for cultural and academic diversity
   (g) Collaborates effectively with stakeholders
   (h) Demonstrates self-regulated learner behaviors/takes initiative
   (i) Exhibits the social and emotional intelligence to promote personal and educational goals/stability

MATH 490, Special Topics in Mathematics

The learning outcomes for MATH 490 vary by the course content.

MATH 495, Independent Study in Mathematics

The learning outcomes for MATH 495 vary by the course content.

MATH 496, Mathematics Seminar

The learning outcomes for MATH 496 vary by the course content.

STAT 345, Applied Statistics I

The class STAT 345 has not been offered in over five years. The department does not have a current syllabus for this course. Should we offer this course, we will need to revise the course description and create a syllabus. Accordingly, we have no Learning Outcomes for this class.

STAT 399, Internship

The Learning Outcomes are the following:

(1) Write a two page description of the activities of the internship.

(2) Give three examples in which topics you learned in undergraduate mathematics courses came up and/or were used in an activity of the internship. Describe and discuss. If three examples cannot be given, list one, or two, if possible, and say that there were less than three.

(3) Give any examples of mathematical topics that came up and/or were used in an activity of the internship that you had not seen before. Describe and discuss.

(4) Describe two jobs and/or careers for which the experience of the internship made you more qualified than you were before.

(5) Fill in the blank: I would have been better prepared for the internship if I had previously _____.

(6) Fill in the blank: My next step(s) in developing a career path is(are) _____

STAT 441, Probability and Statistics

On completion of this course, students will be able to

(1) Demonstrate an understanding of the concepts of sample space, random variable, and probability of an event.

(2) Demonstrate an understanding of the axioms and basic theorems regarding probability measures.

(3) Demonstrate an understanding of conditional probability.

(4) Calculate the probability of an event in a discrete sample space when all the outcomes are equally likely using the sample-point method and basic counting techniques.

(5) Calculate the probability of an event in a sample space and when the outcomes are not equally likely using the event-composition method.

(6) Calculate the mean, variance, and standard deviation of an arbitrary discrete or continuous distribution.

(7) Demonstrate an understanding of the mathematical derivations of the formulas for the mean and variance of an assortment of special discrete and continuous distributions including the: binomial, geometric, hypergeometric, Poisson, uniform, and normal distributions.

(8) Demonstrate an understanding of the similarities and differences between the cumulative distribution function of a discrete random variable and that of a continuous random variable.

(9) Demonstrate an understanding of moments and how moment generating functions for various distributions can be found and used to determine formulas for the mean and variance of distributions.

(10) Demonstrate an understanding of the mathematical derivations of an assortment of the techniques of statistical analysis, particularly in the areas of estimation (of means, variances, and standard deviations) and of hypothesis testing.

STAT 442, Mathematical Statistics

The class STAT 442 has not been offered in over five years. The department does not have a current syllabus for this course. Should we offer this course, we will need to revise the course description and create a syllabus. Accordingly, we have no Learning Outcomes for this class.

STAT 495, Independent Study in Statistics

The learning outcomes for STAT 495 vary by the course content.