

Syllabus: MATH 230
Data Analysis and Probability for the Middle Level Teacher

Catalog Description with Prerequisites

This course is designed for middle level (4-8) teaching candidates as an introduction to probability and statistic. This course will include descriptive statistics, counting and basic probability, random variables and probability distributions, concept of random sampling. Statistical inference, confidence intervals and hypothesis testing will also be covered at an appropriate level.

Prerequisite: passing score on BST, and C or better in MATH 104 or department permission

The primary orientation is to provide future Middle Level mathematics teachers with an understanding of the basic concepts of statistics and probability as mandated by the Pennsylvania Department of Education in the Pennsylvania Academic Standards for Teaching Mathematics. Class time will be devoted to modeling and discussing appropriate pedagogy. The focus in this course will be geared toward the use of activities and technology in the presentation and analysis of data. Class time will be devoted to the specific use of graphing calculators and statistical software. The laboratory component of the course will emphasize the analysis of data sets collected by the students.

Primary Course Objectives

Upon completion of the course, students will be able to:

Objective	Forms of Assessment
1. Apply basic concepts of statistics, including descriptive statistics to analyze and describe relevant data.	Exams, Projects/Labs, Group Work, Class Activities, Problem Sets
2. Apply basic concepts of probability including counting principles, random variables and probability distributions.	Exams, Projects/Labs, Group Work, Class Activities, Problem Sets
3. Use data to make decisions.	Exams, Projects/Labs, Group Work, Activities, Problem Sets
4. Use course techniques to formulate a problem, collect data, conduct the analysis, and explain the solution.	Group Work, Projects, Labs, Activities
5. Use appropriate technology (graphing calculators and computers) to problem solve and facilitate a clear application of their understanding of the key concepts of statistics and probability in the classroom.	Problem Sets, Labs, Projects
6. Apply the Data Analysis and Probability Standards from the NCTM Principles and Standards for School Mathematics and the Pennsylvania Academic Standards for Teaching Mathematics.	Exams, Group Work, Problem Sets
7. Connect the content of statistics and probability to appropriate pedagogy for Middle Level teaching.	Group Work, Activities

In addition to the above course objectives, MATH 230 will help teacher candidates at the Middle Level to fulfill university, state, and national standards as indicated below.

I. In alignment with Millersville University's Professional Education Unit's Conceptual Framework, this course will serve to satisfy key indicators for Proficiency Area I: Content Knowledge. Candidates will display knowledge of the mathematical content and apply the important principles and concepts delineated in professional, state, and institutional standards.

Specifically candidates will:

- Demonstrate competency in their chosen content area.
- Engage in inquiry in their content area that develops their ability to extend student understanding beyond surface information.
- Understand, explain, and apply knowledge of the contextual issues (e.g., political, social, cultural, ethnicity, disability, and gender) that influence their content area.
- Recognize various theories and points of view within their field.
- Develop curricula in a variety of instructional formats reflective of state, national, and local standards.

II. PDE Standards that teacher candidates will be better prepared to help their own students to achieve after completing this course include the following:

- PDE 2.6.8 A: Compare and contrast different plots of data using values of mean, median, mode, quartiles and range.
- PDE 2.6.8 B: Explain effects of sampling procedures and missing or incorrect information on reliability.
- PDE 2.6.8 C: Fit a line to the scatter plot of two quantities and describe any correlation of the variables.
- PDE 2.6.8 D: Design and carry out a random sampling procedure.
- PDE 2.6.8 E: Analyze and display data in stem-and-leaf and box-and-whisker plots.
- PDE 2.6.8 F: Use scientific and graphing calculators and computer spreadsheets to organize and analyze data.
- PDE 2.6.8 G: Determine the validity of the sampling method described in studies published in local or national newspapers.

III. Content Knowledge Standard for mathematics teachers from National Council of Teachers of Mathematics for the National Council for the Accreditation of Teacher Educators (2003).

Standard 14: Knowledge of Data Analysis, Statistics, and Probability: Candidates demonstrate an understanding of concepts and practices related to data analysis, statistics, and probability.

Indicators

- 14.1 Design investigations, collect data, and use a variety of ways to display data and interpret data representations that may include bivariate data, conditional probability and geometric probability.
- 14.2 Use appropriate methods such as random sampling or random assignment of treatments to estimate population characteristics, test conjectured relationships among variables, and analyze data.
- 14.3 Use appropriate statistical methods and technological tools to describe shape and analyze spread and center.
- 14.4 Use statistical inference to draw conclusions from data.
- 14.5 Identify misuses of statistics and invalid conclusions from probability.
- 14.6 Draw conclusions involving uncertainty by using hands-on and computer-based simulation for estimating probabilities and gathering data to make inferences and conclusions.
- 14.7 Determine and interpret confidence intervals.
- 14.8 Demonstrate knowledge of the historical development of statistics and probability including contributions from diverse cultures.

Comprehensive Outline of Course Content

- 1) Introduction {1 week}

- a) Nature of Statistics
 - i) Role of Data
 - ii) Role of Probability
- b) Nature of Data
- 2) Descriptive Statistics (Univariate & Bivariate) {3 weeks} *[4 Labs]*
 - a) Data Displays
 - i) Categorical Data – Bar Graphs, Circle Graphs, Pie Graphs
 - ii) Quantitative Data – Histograms, Stem-and-Leaf, Dot-plots, Scatter-plots
 - b) Numerical Summary Statistics
 - i) Measures of Center/Location – Mode, Median, Mean
 - ii) Measures of Spread/Variation – Range, Variance, Standard Deviation
 - iii) Measures of Position – Z-Score, Empirical Rule, 5- number Summary, Box-plots
 - iv) Measures of Association Between 2 Quantitative Data Variables – Correlation, Best Fit Line
- 3) Basic Probability {2 weeks} *[1 Lab]*
 - a) Random phenomena and random experiments
 - i) sample spaces and events
 - ii) combining events
 - iii) mutually exclusive events
 - b) Definitions of Probability
 - i) relative frequency probability
 - ii) equally likely outcomes probability
 - c) Fundamental Properties of Probability
 - i) additive property (mutually exclusive and non-mutually exclusive events)
 - ii) complement
 - iii) multiplicative property
 - (1) tree diagrams
 - (2) conditional probability
 - iv) independent events
 - d) Counting – Multiplication Rule
- 4) Random Variables And Probability Distributions {3+ weeks} *[2 Labs]*
 - a) Random Variables
 - b) Mean And Standard Deviation Of Random Variables
 - c) Special Random Variables
 - i) Binomial Experiment, Binomial Random Variable, Binomial Distribution
 - ii) Normal Random Variable, Normal Distribution
 - d) Random Sampling and Sampling Distributions
 - i) Data Collection
 - ii) Distribution Of Sample Means
 - (1) Central Limit Theorem
 - (2) t-Distribution
 - iii) Distribution Of Sample Proportions
- 5) Statistical Inference (Single Parameter) – Decisions Based Upon Data {3+ weeks} *[2 Labs]*
 - a) Estimating With Confidence
 - i) Nature of Point Estimation
 - ii) Nature of Confidence Intervals
 - (1) Confidence Intervals For Proportions, Sample Size
 - (2) Confidence Intervals For Means, Sample Size
 - b) Testing Hypotheses
 - i) Nature of Hypothesis Testing
 - (1) Hypotheses, Type 1 Error, Type 2 Error

- (2) Summarize the Evidence
- (3) Assess the Evidence (P-Value)
- (4) Reach Conclusion
- ii) Testing About Proportions
- iii) Testing About Means
- 6) Synthesis of Statistical Ideas and Pedagogy {through-out the course}

Notes:

Lab Experiences: Some labs with consist of focused efforts on the use of statistical software (examples include: Minitab, Fathom, and Web applets) & graphing calculators and will concentrate on using the technology for doing statistics and using the technology to teach important concepts. Other labs will challenge the student's understanding of the concepts using hands-on activities and simulations; "Focus on Understanding" activities.

Criteria for Evaluating Student Performance

Evaluation of student learning objectives will be measured through a combination of the following assessments:

- In-class exams
 - Final exam
- Regularly collected and graded work including:
 - Problem sets
 - Projects
 - Individual and group work involving:
- In/out of class hands-on activities
 - Data collection
 - Simulations
- Labs (computer and calculator investigations of data)

Required Materials:

Textbook

Data and Probability Connections: Mathematics for Middle School Teachers

by Debra and Michael Perkowski, 2007

Calculator Requirement

Students are required to have a graphing calculator (TI-84 or comparable graphing calculator).

General Education Credit

This course will satisfy G2 credit for MATH.

Resources

Throughout the course there will be a strong focus on deep conceptual understanding

- 1) of the mathematical and statistical ideas themselves, and
- 2) of the connections of these mathematical ideas to the teaching of these concepts to the Middle Level.

Understanding of the Data Analysis and Probability Standards – NCTM Principles and Standards for School Mathematics. Reference: <http://standards.nctm.org/document/appendix/data.htm>

- Formulate questions that can be addressed with data ...
and collect, organize, and display relevant data to answer them
- Select and use appropriate statistical methods to analyze data
- Develop and evaluate inferences and predictions that are based on data
- Understand and apply basic concepts of probability

Understanding the Nature of Variability - Guidelines for Assessment and Instruction in Statistics Education (GAISE) Reference: <http://www.amstat.org/education/gaise/>

- Measurement Variability
- Natural Variability
- Induced Variability
- Sampling Variability