

George Mason University
College of Education and Human Development
Mathematics Education Leadership

MATH 612.001 – Probability and Statistics for K-8 Teachers
3 Credits, Spring 2018
Wednesdays (4:30-7:10) Robinson A 349 – Fairfax

Faculty

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Prerequisites/Corequisites

Admission to the Mathematics Education Leadership Master's Degree Program or instructor permission. Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus. Enrollment is limited to Graduate, Non-Degree or Undergraduate level students. Students in a Non-Degree Undergraduate degree may **not** enroll.

University Catalog Course Description

An introduction to probability, descriptive statistics, and data analysis. Topics studied will include the exploration of randomness, data representation, modeling. Descriptive statistics will include measures of central tendency, dispersion, distributions, and regression. The analysis of experiments requiring hypothesizing, experimental design and data gathering will also be discussed.

Course Overview

This course is for future K-8 mathematics teacher specialists will cover the Virginia SOL strands in probability and statistics, especially those in grades 5-8. Special attention will be given to interpreting and assessing students' work and learning.

Course Delivery Method

This course will be delivered using a lecture format.

Learner Outcomes or Objectives

This course is designed to enable students to do the following:

1. Candidates will develop a comprehensive understanding of probability and statistics reasoning, representation and data collection.
2. Candidates will examine in depth probability and statistics content appropriate for K-8 mathematics teachers, including the use of technology to study probability and statistics and historical connections to probability and statistics.
3. Candidates will explore fundamentals of data collection, data analysis, probability, statistics, and relationships.
4. Candidates will examine probability and statistics Habits of Mind, in order to assess their own progress throughout the course and to discover these models' pedagogical implications on classroom instruction.

Professional Standards (National Council of Teachers of Mathematics (NCTM))

Upon completion of this course, students will have met the following professional standards: To be prepared to support the development of student mathematical proficiency, all elementary mathematics specialists should know the following topics related to statistics and probability with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:

- C.4.1 Statistical variability and its sources and the role of randomness in statistical inference
- C.4.2 Construction and interpretation of graphical displays of univariate and bivariate data distributions (e.g., box plots and histograms), summary measures (mean, median, mode, interquartile range, and mean absolute deviation) and comparison of distributions of univariate data, and exploration of categorical (discrete) and measurement (continuous) data
- C.4.3 Empirical and theoretical probability for both simple and compound events
- C.4.4 Random (chance) phenomena and simulations
- C.4.5 Historical development and perspectives of statistics and probability including contributions of significant figures and diverse cultures

Standard 2: Mathematical Practices (NCTM NCATE Mathematics Content for Elementary Mathematics Specialist *Addendum to the NCTM NCATE Standards 2012*)

In their role as teacher, lead teacher, and/or coach/mentor, elementary mathematics specialist candidates:

- 3a) Apply knowledge of curriculum standards for elementary mathematics and their relationship to student learning within and across mathematical domains in teaching elementary students and coaching/mentoring elementary classroom teachers.
- 3c) Plan and assist others in planning lessons and units that incorporate a variety of strategies, differentiated instruction for diverse populations, and mathematics-specific instructional technologies in building all students' conceptual understanding and procedural proficiency.

3e) Implement and promote techniques related to student engagement and communication including selecting high quality tasks, guiding mathematical discussions, identifying key mathematical ideas, identifying and addressing student misconceptions, and employing a range of questioning strategies.

5b) Engage students and coach/mentor teachers in using developmentally appropriate mathematical activities and investigations that require active engagement and include mathematics-specific technology in building new knowledge.

Required Texts

National Council of Teachers of Mathematics. (2013). *Developing essential understanding of statistics for teaching mathematics in grades 6-8*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2014). *Principles to actions: ensuring mathematical success for all*. Reston, VA: National Council of Teachers of Mathematics.

Recommended Texts

National Council of Teachers of Mathematics. (2002). *Navigating through Data Analysis and Probability in Prekindergarten-Grade 2*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2003). *Navigating through Data Analysis and Probability in Grades 3-5*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2003). *Navigating through Data Analysis and Probability in Grades 6-8*. Reston, VA: National Council of Teachers of Mathematics.

Course Performance Evaluation

Students are expected to submit all assignments on time in the manner outlined by the instructor (e.g., Blackboard, Tk20, hard copy).

- **Assignments and/or Examinations**

- A. Reflections (50%) – Performance Based Assessment**

- NCATE/NCTM Indicator 1a (C.2.1 - C. 2.5), 2a, 2b, 2c, 2f

- Student will reflect on four rich mathematical tasks problem and submit a reflection for each. Additionally, students will explore a historical figure and write a reflection on the historical contribution.

- B. Individual Content Assessments (20%)**

Students will complete various individual content assessments that will assess their individual understanding of K-8 probability and statistics content.

C. Technology Project (20%)

Explore probability and statistics specific technology (ie: virtual graphing software, Geogebra, etc. NOT Smartboards, iPads, etc.). Prepare a short presentation for teachers that explains how the technology can be used for probability and statistics in multiple grade levels. The presentation should be interactive and engage teachers in using the technology to explore a task.

D. Participation (10%)

Students are expected to participate actively. This requires students to consider probability and statistics using different strategies and a variety of manipulatives and resources. During math work time, students should be developing algorithms for the entire work time, or discussing and sharing algorithms with each other. During math-talk and discussion times, students should be actively engaged by voicing their thoughts and connecting to topics presented during the discussion.

Other Requirements

It is your responsibility to attend all class sessions. Please report your reasons for any absences to the instructor in writing.

Tardiness: It is your responsibility to be on time for each class session. Please report your reasons for any tardiness to the instructor in writing.

Class materials will be posted for each class session on Blackboard. Students are responsible for reviewing these materials and submitting required artifacts (where appropriate) to online class discussion boards.

Grading Policy (Graduate Grading Scale)

A 93%-100%	B+ 87%-89%	C 70%-79%
A- 90%-92%	B 80%-86%	F Below 70%

At the graduate level all work is expected to be of high quality and submitted on the dates due. Work submitted late will be penalized 10% for every day of delay. If you have any extraordinary circumstances that prevent you from submitting your work in a timely manner, it is your responsibility to contact the instructor as soon as possible after the circumstances occur and make arrangements to complete your work. It is up to the discretion of the instructor to approve the timeline for late/makeup work.

For Master's Degrees:

Candidates must have a minimum GPA of 3.00 in coursework presented on the degree application, which may include no more than 6 credits of C. (Grades of C+, C-, or D do not apply to graduate courses. The GPA calculation excludes all transfer courses and Mason non-degree studies credits not formally approved for the degree).

For Endorsement Requirements

Candidates must have a grade of B or higher for all licensure coursework (endorsement coursework).

Professional Dispositions

Students are expected to exhibit professional behaviors and dispositions at all times. Education professionals are held to high standards, both inside and outside of the classroom. Educators are evaluated on their behaviors and interactions with students, parents, other professionals, and the community at large. At the College of Education and Human Development, dispositions may play a part in the discussions and assignments of any/all courses in a student's program (and thus, as part or all of the grade for those assignments). For additional information visit:

<https://cehd.gmu.edu/students/polices-procedures/>

In order to maintain a focused class, laptops and cell phones are to be used exclusively for the current class topic. Examples of this include searching for math standards, videos of mathematical algorithms, taking pictures of manipulatives, etc. Emailing, texting, and other forms of communication and social media are not permitted during class time unless it is directly related to the activity. In addition, students should refrain from grading papers and preparing lesson materials for their school placements during class time.

Commented [TEW1]: I added this here, but you may delete it or edit it as needed.

Schedule

Date	Assignment Due
January 24 Introduction to probability	
January 31 Probability: Empirical and theoretical	READINGS PTA: Effective Teaching and Learning (p.7 - 12) STAT: Introduction (p. 1) ASSIGNMENTS PBA #3 Due
February 7 Probability as a tool for statistics	READINGS PTA: Establish Mathematics Goals to Focus Learning (p.12) STAT: Probability as a tool for statistics (p. 89-91) ASSIGNMENTS Technology Project Part 1 Due

Commented [TEW2]: Students need to investigate technology, but you can determine the project and due dates.

	Sign up for Technology Project Tool
February 14* Problem solving using categorical Data *Online Asynchronous Class	READINGS PTA: Implement Tasks That Promote Reasoning and Problem Solving (p. 17) STAT: Displaying distributions of categorical data (p. 13 – 17) STAT: Numerical summaries of categorical data (p. 17 – 19) ASSIGNMENTS PBA #4 Due
February 21 Connecting representations of quantitative data	READINGS PTA: Use and Connect Mathematical Representations (p. 24) STAT: Displaying distributions of quantitative data (p. 19 – 21) STAT: Assessing Statistical Understanding (p. 100 – 104) ASSIGNMENTS Individual Content Assessment #1 Due
February 28* Meaningful discourse using math terms for center *Online Synchronous Class	READINGS PTA: Facilitate Meaningful Mathematical Discourse (p. 29) STAT: Measuring the center of a distribution (p. 21 – 24) STAT: Measuring the amount of variability in a distribution (p. 24 – 28) ASSIGNMENTS Technology Presentations Group 1
March 7 What questions does your data answer?	READINGS PTA: Pose Purposeful Questions (p. 35) STAT: Grouping Data (p. 28 – 31) STAT: The shape of a distribution (p. 32) ASSIGNMENTS Individual Content Assessment #2 Due
March 14* *No Class	GMU Spring Break – No Class
March 21 Understanding the outliers	READINGS PTA: Build Procedural Fluency from Conceptual Understanding (p. 42) STAT: An alternative grouping strategy (p. 32 – 35) STAT: Outliers (p. 36 – 41)

Commented [TEW3]: This works for my schedule, but it can be changed for each class

Commented [TEW4]: You can choose a variety of content assessments – the traditional midterm and final or several scattered throughout the semester, or one problem every night. These are graded for mastery.

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	<p>ASSIGNMENTS</p> <p>Individual Content Assessment #3 Due</p>
<p>March 28*</p> <p>Graphing in our world</p> <p>*Online Asynchronous Class</p>	<p>ASSIGNMENTS</p> <p>Asynchronous Assignment Due</p>
<p>April 4</p> <p>Productive struggle in statistics</p>	<p>READINGS</p> <p>PTA: Support Productive Struggle in Learning Mathematics (p. 48)</p> <p>STAT: Comparing Distributions: Big Idea 2 (p.42 – 50)</p> <p>ASSIGNMENTS</p> <p>PBA #2 Due</p>
<p>April 11</p> <p>Using student work to ask questions about data</p>	<p>READINGS</p> <p>PTA: Elicit and Use Evidence of Student Thinking (p. 53)</p> <p>STAT: Associations between Two Variables: Big Idea 3 (p.51-65)</p> <p>ASSIGNMENTS</p> <p>PBA #1 Due</p>
<p>April 18*</p> <p>Samples and Populations</p> <p>*Online Synchronous Class</p>	<p>READINGS</p> <p>STAT: Samples and Populations: Big Idea 4 (p.67 – 78)</p> <p>ASSIGNMENTS</p> <p>Technology Presentations Group 2</p>
<p>April 25*</p> <p>Math leadership in probability and statistics</p> <p>*Online Asynchronous Class</p>	<p>READINGS</p> <p>STAT: Connections: Looking Back and Ahead in Learning (p. 81 – 92)</p> <p>ASSIGNMENTS</p> <p>Individual Content Assessment #4 Due</p> <p>Asynchronous Assignment Due</p> <p>If you are attending NCSM or NCTM, you do not need to complete the asynchronous assignment. Documentation Required.</p>
<p>May 2</p> <p>Challenges in teaching probability and statistics</p>	<p>READINGS</p> <p>STAT: Challenges: Learning, Teaching, and Assessing (p. 93 – 104)</p> <p>ASSIGNMENTS</p>

Commented [TEW6]: Many schools are off on this day, so I keep it asynchronous. You don't need to, but attendance is frequently lower when it meets.

Commented [TEW7]: This works for my schedule, but it can be changed for each class

Core Values Commitment

The College of Education and Human Development is committed to collaboration, ethical leadership, innovation, research-based practice, and social justice. Students are expected to adhere to these principles: <http://cehd.gmu.edu/values/>.

GMU Policies and Resources for Students

Policies

- Students must adhere to the guidelines of the Mason Honor Code (see <http://oai.gmu.edu/the-mason-honor-code/>).
- Students must follow the university policy for Responsible Use of Computing (see <http://universitypolicy.gmu.edu/policies/responsible-use-of-computing/>).
- Students are responsible for the content of university communications sent to their Mason email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students **solely** through their Mason email account.
- Students with disabilities who seek accommodations in a course must be registered with George Mason University Disability Services. Approved accommodations will begin at the time the written letter from Disability Services is received by the instructor (see <http://ods.gmu.edu/>).
- Students must follow the university policy stating that all sound emitting devices shall be silenced during class unless otherwise authorized by the instructor.

Campus Resources

- Support for submission of assignments to Tk20 should be directed to tk20help@gmu.edu or <https://cehd.gmu.edu/aero/tk20>. Questions or concerns regarding use of Blackboard should be directed to <http://courssupport.gmu.edu/>.
- The Writing Center provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing (see <http://writingcenter.gmu.edu/>).
- The Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide

range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance (see <http://caps.gmu.edu>).

- The Student Support & Advocacy Center staff helps students develop and maintain healthy lifestyles through confidential one-on-one support as well as through interactive programs and resources. Some of the topics they address are healthy relationships, stress management, nutrition, sexual assault, drug and alcohol use, and sexual health (see <http://ssac.gmu.edu>). Students in need of these services may contact the office by phone at 703-993-3686. Concerned students, faculty and staff may also make a referral to express concern for the safety or well-being of a Mason student or the community by going to <http://ssac.gmu.edu/make-a-referral/>.

For additional information on the College of Education and Human Development, please visit our website <https://cehd.gmu.edu/>.

Probability and Statistics Content and Practices Task Reflection: Course Performance Based Assessments

This is a Performance Based Assessment that addresses the following NCTM Math Specialist Standards:

- NCTM Elements: 1a, 2a, 2b, 2c, 2, f
- NCTM Content Standard: C.4.1, C.4.2, C.4.3 & C.4.4

The purpose of this Course Performance Based Assessment is for the candidate to demonstrate preparedness to support the development of student mathematical proficiency. All elementary mathematics specialists should know the above topics related to probability and statistics with their content understanding and mathematical practices.

The candidate will complete a task and written reflection connected to their current mathematical understanding and how it has changed over the duration of the course. The final product will be submitted on Blackboard in Tk20. For a complete rubric and grading criteria please see the rubric below.

Summary of Actions

- Solve the problem set using multiple strategies (concrete, pictorial and abstract). Show your work and include pictures of all concrete representations.
- Reflect on your problem by answering the questions for the written reflection paper.
- Submit the following to Tk20: 1) task strategies with work samples; and 2) written reflection paper.

Probability and Statistics Content & Practices Task Reflection

Course Performance Based Assessment

Reflection Logs 1-4 Rubric

Level/Criteria	4 Exceeds Expectations	3 Meets Expectations	2 Developing	1 Does Not Meet Expectations
BUILDING CONCEPTUAL AND PROCEDURAL UNDERSTANDING NCTM Element 1.a Demonstrate and apply knowledge of major mathematics concepts, algorithms, procedures, applications in varied contexts and connections.	The candidate includes all of the following elements: <ul style="list-style-type: none"> • Application of conceptual and procedural knowledge in identifying solutions in the problem set • Explanation of the development of conceptual to procedural knowledge • Discussion of new knowledge gained and the connections to past knowledge and experiences 	The candidate includes two of the following elements: <ul style="list-style-type: none"> • Application of conceptual and procedural knowledge in identifying solutions in the problem set • Explanation of the development of conceptual to procedural knowledge • Discussion of new knowledge gained and the connections to past knowledge and experiences 	The candidate includes one of the following elements: <ul style="list-style-type: none"> • Application of conceptual and procedural knowledge in identifying solutions in the problem set • Explanation of the development of conceptual to procedural knowledge • Discussion of new knowledge gained and the connections to past knowledge and experiences 	The candidate does not include any of the following elements: <ul style="list-style-type: none"> • Application of conceptual and procedural knowledge in identifying solutions in the problem set • Explanation of the development of conceptual to procedural knowledge • Discussion of new knowledge gained and the connections to past knowledge and experiences
PROBLEM SOLVING NCTM Element 2.a Use problem solving to develop conceptual understanding, make a sense of a wide variety of problems and persevere in solving them, apply and adapt a variety of strategies in solving problems confronted within the field of mathematics and other contexts, and	The candidate includes all of the following elements: <ul style="list-style-type: none"> • Describes the use of problem solving within the problem set to formulate generalizations • Explains how to make sense of the problems in the problem set • Apply a variety of strategies and representations to 	The candidate includes two of the following elements: <ul style="list-style-type: none"> • Use of problem solving within the problem set to formulate generalizations • Make sense of the problems in the problem set • Apply a variety of strategies and representations to the problem set 	The candidate includes one of the following elements: <ul style="list-style-type: none"> • Use of problem solving within the problem set to formulate generalizations • Make sense of the problems in the problem set • Apply a variety of strategies and representations to the problem set 	The candidate does not include any of the following elements: <ul style="list-style-type: none"> • Use of problem solving within the problem set to formulate generalizations • Make sense of the problems in the problem set • Apply a variety of strategies and representations to the problem set

formulate and test conjectures in order to frame generalizations.	the problem set			
<p>REPRESENTATIONS</p> <p>NCTM Element 2.b</p> <p>Reason abstractly, reflectively, and quantitatively with attention to units, constructing viable arguments and proofs, and critiquing the reasoning of others; represent and model generalizations using mathematics; recognize structure and express regularity in patterns of mathematical reasoning; use multiple representations to model and describe mathematics; and utilize appropriate mathematical vocabulary and symbols to communicate mathematical ideas to others.</p>	<p>The candidate includes all of the following elements:</p> <ul style="list-style-type: none"> • Describes how multiple representations were used to model the problem set • Discusses how the representations support the creation of generalizations • Uses appropriate mathematical vocabulary and symbols 	<p>The candidate includes two of the following elements:</p> <ul style="list-style-type: none"> • Describes how multiple representations were used to model the problem set • Discusses how the representations support the creation of generalizations • Uses appropriate mathematical vocabulary and symbols 	<p>The candidate includes one of the following elements:</p> <ul style="list-style-type: none"> • Describes how multiple representations were used to model the problem set • Discusses how the representations support the creation of generalizations • Uses appropriate mathematical vocabulary and symbols 	<p>The candidate does not include any of the following elements:</p> <ul style="list-style-type: none"> • Describes how multiple representations were used to model the problem set • Discusses how the representations support the creation of generalizations • Uses appropriate mathematical vocabulary and symbols
<p>CONTEXT</p> <p>NCTM Element 2.C</p> <p>Formulate, represent, analyze, and interpret mathematical models derived from real-world contexts of mathematical problems.</p>	<p>The candidate includes all of the following elements:</p> <ul style="list-style-type: none"> • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation 	<p>The candidate includes two of the following elements:</p> <ul style="list-style-type: none"> • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation 	<p>The candidate includes one of the following elements:</p> <ul style="list-style-type: none"> • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation 	<p>The candidate does not include any of the following elements:</p> <ul style="list-style-type: none"> • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation

	of the solution	of the solution	of the solution	of the solution
<p>NCTM PROCESS STANDARDS</p> <p>NCTM Element 2.F</p> <p>Use and assist teachers in using resources from professional mathematics education organizations such as teacher/leader discussion groups, teacher networks, and print, digital, and virtual resources/collections</p>	<p>The candidate includes a reflection on the process standards that includes a description of how each of the five NCTM Process Standards impact the mathematical understanding.</p> <p>The reflection includes specific instances where the candidate assisted teachers using all of the following elements:</p> <ul style="list-style-type: none"> • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/collections 	<p>The candidate includes a reflection on the process standards that includes a description of how four of the five NCTM Process Standards impact the mathematical understanding.</p> <p>The reflection includes specific instances where the candidate assisted teachers using two of the following elements:</p> <ul style="list-style-type: none"> • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/collections 	<p>The candidate includes a reflection on the process standards that includes a description of how three of the five NCTM Process Standards impact the mathematical understanding.</p> <p>The reflection includes specific instances where the candidate assisted teachers using one of the following elements:</p> <ul style="list-style-type: none"> • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/collections 	<p>The candidate includes a reflection on the process standards that includes a description of how one or two NCTM Process Standards impact the mathematical understanding.</p> <p>The reflection does not include any specific instances where the candidate assisted teachers using all of the following elements:</p> <ul style="list-style-type: none"> • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/collections

Reflection Log 5 rubric

The final reflection log will involve researching a major mathematical historical development and the contributions of a historically significant figure. We will discuss many of these developments and figures during the math talk all throughout the semester. However, this discussion will be brief. Once you find a topic that interests you, you should research it further. The following reflection should be about 2 pages in length and will be evaluated using the following criteria.

Levels/Criteria	4	3	2	1
	Exceeds Expectations	Meets Expectations	Developing	Does Not Meet Expectations
NCTM Indicator C.1.5 Historical development of probability and statistics.	Essay describes the historical development of probability and statistics in depth and provides specific examples.	Essay describes the historical development of probability and statistics and provides specific examples.	Essay describes the historical development of probability and statistics and provides an example.	Essay includes incomplete description of historical development of probability and statistics.
NCTM Indicator C.1.5 Historical perspectives of probability and statistics.	Essay describes the historical perspectives of probability and statistics in depth and provides specific examples.	Essay describes the historical perspectives of probability and statistics and provides specific examples.	Essay describes the historical perspectives of probability and statistics and provides an example.	Essay includes incomplete description of historical perspectives of probability and statistics.
NCTM Indicator C.1.5 Contributions of historically significant figures and diverse cultures.	Essay describes contributions of historically significant figures and diverse cultures in depth and provides specific examples.	Essay describes contributions of historically significant figures and diverse cultures and provides specific examples.	Essay describes contributions of historically significant figures and diverse cultures and provides an example.	Essay includes incomplete description of historically significant figures and diverse cultures.