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

MATH 612.6M2/6M4 – Probability and Statistics for K-8 Teachers
3 Credits, Spring 2020
Tuesday 4:45-7:25 at Willow Oaks in Room 1000A except Feb. 4 and Mar 3 in Room
1002A/B and Mar 10 at Gatehouse Room 3050/3051

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 and hybrid (2-75% online) format.

Learner Outcomes or Objectives

This course is designed to enable students to do the following:
1. Develop a comprehensive understanding of probability and statistics reasoning, representation and data collection.
2. 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. Explore the fundamentals of data collection, data analysis, probability, statistics, and relationships.
4. 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)

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

Russell, S. J., Shifter, D., & Bastable, V. (2018). *Statistics: Modeling with data casebook.* 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

Van de Walle, J., Karp, K, & Bay-Williams, J. (2018). *Elementary and middle school mathematics: Teaching developmentally* (10th edition). Boston, MA: Pearson Education.

American Psychological Association (2010*). Publication Manual of the American Psychological Association* (7th edition). Washington, DC: American Psychological Association.

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 submitted late without prior approval from the instructor will not be graded for full credit.

All assignments require APA formatting. See recommended texts for resources on APA formatting. Specifically, the following aspects of APA formatting should be addressed in any submission:
- 12 point, Times New Roman font
- Double spaced
- Page headers/Running head
- Cover page with title, author's name and professional affiliation
- References
- Headings
- Citations
- Clearly organized, grammatically correct, coherent and complete
- Professional language (i.e. no jargon)

- **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 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. STEM Integration Project (20%)
  Explore a probability and statistics rich task using math specific technology (ie: virtual graphing software, Geogebra, etc. NOT Smartboards, iPads, etc.) and science or engineering. Prepare a short presentation for teachers that explains how the task, technology, and science or engineering 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. Develop a lesson plan for the rich task including student work samples and misconceptions.

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 <u>entire</u> 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.

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

- **For Master's Degrees**:
  Candidates must have a minimum GPA of 3.00 in coursework presented on the degree application, <u>which may include no more than 6 credits of C</u>. (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

 See https://cehd.gmu.edu/students/polices-procedures/

Class Schedule

Date	Location	Readings & Assignments Due by Start of Class
January 21 **Introduction to Probability** **PBA #3 – Stan the Ice Cream Man Task**	Willow Oaks, Room 1000A	
January 28 **Empirical and Theoretical Probability** **Introduce PBA #4 – Probability Fair (Reflection due 3/31)**	Willow Oaks, Room 1000A	**READINGS** PTA: Effective Teaching and Learning (pp. 7 - 12) STAT: Introduction **ASSIGNMENTS** PBA #3 Reflection
February 4 **Probability as a Tool for Statistics** **Introduce PBA #2 – Graphs Galore (Reflection due 4/28)**	**Willow Oaks, Room 1002A/B**	**READINGS** PTA: Establish Mathematics Goals to Focus Learning (pp. 12 - 16) STAT: Chapter 1 Getting Started with Data (Cases 1-3) Reading on Bboard: Determining Probabilities by Examining Underlying Structure from *Rich & Engaging Mathematical Tasks Grades 5-9* **ASSIGNMENTS** Individual Content Assessment #1
February 11 **Problem Solving using Categorical Data** **Introduce STEM Integration Project (Phase 1 due 2/25)**	Willow Oaks, Room 1000A	**READINGS** PTA: Implement Tasks That Promote Reasoning and Problem Solving (pp. 17 - 24) STAT: Chapter 2 Designing a Data Investigation (Cases 4-6) **ASSIGNMENTS** None
February 18 **Connecting representations of quantitative data** **Introduce PBA #5- Historical Reflection (due 3/3)**	Willow Oaks, Room 1000A	**READINGS** PTA: Use and Connect Mathematical Representations (pp. 24 - 29) STAT: Chapter 3 Categorical Data Part 1 (pp. 27-37 Cases 7 - 8) **ASSIGNMENTS** Individual Content Assessment #2

February 25 **Meaningful discourse using math terms for center**	Willow Oaks, Room 1000A	**READINGS** PTA: Facilitate Meaningful Mathematical Discourse (pp. 29 - 35) STAT: Chapter 3 Categorical Data Part 2 (pp. 38 - 50 Cases 9-11) Reading on Bboard: Developing a Meaningful Understanding of the Mean from Rich & Engaging Mathematical Tasks Grades 5-9 **ASSIGNMENTS** STEM Integration Project Phase 1 – Task Identification
March 3 **What questions does your data answer?**	**Willow Oaks, Room 1002A/B**	**READINGS** PTA: Pose Purposeful Questions (pp. 35 - 41) STAT: Chapter 4 Numerical Data Part 1 (pp. 51 – 56 Case 12) Reading on Bboard: Exploring Probability through an Evens-Odds Dice Game from Rich & Engaging Mathematical Tasks Grades 5-9 **ASSIGNMENTS** PBA #5 Historical Reflection
March 10 **(GMU Spring Break)** **Understanding the outliers** **PBA #1 – Fishy Data Task**	**Gate House Room 3050/3051**	**READINGS** PTA: Build Procedural Fluency from Conceptual Understanding (pp. 42 - 48) STAT: Chapter 4 Numerical Data Part 2 (pp. 57 – 76 Cases 13 - 16) Reading on Bboard: Rethinking Fair Games from Rich & Engaging Mathematical Tasks Grades 5-9 **ASSIGNMENTS** Individual Content Assessment #3
March 17 **STEM in Statistics**	Willow Oaks, Room 1000A	**READINGS** STAT: Chapter 5 Comparing Data Sets (Cases 17-19) **ASSIGNMENTS** PBA #1 Fishy Data Reflection
March 24 **Productive struggle in statistics**	Willow Oaks, Room 1000A	**READINGS** PTA: Support Productive Struggle in Learning Mathematics (pp. 48 - 52) STAT: Chapter 6 Average: Developing Ideas about Middle (Cases 20-24) **ASSIGNMENTS** None

March 31 Using student work to ask questions about data	Willow Oaks, Room 1000A	**READINGS** STAT: Chapter 7 Average: Understanding the Mean (Case 25-28) **ASSIGNMENTS** PBA #4 Probability Fair Reflection
April 7		**No Class**
April 14 (Asynchronous) Samples and Populations	**Online or TBD** **Meetings with STEM Task Peers**	**READINGS** Reading on Bboard: Capture and Recapture Your Students' Interest in Statistics from Rich & Engaging Mathematical Tasks Grades 5-9 **ASSIGNMENTS** STEM Integration Project Phase 2 – Peer Meetings
April 21 Math leadership in probability and statistics	Willow Oaks, Room 1000A	**READINGS** PTA: Elicit and Use Evidence of Student Thinking (pp. 53 - 57) STAT: Chapter 8 Highlights of Related Research Part 1 (pp. 141-153) **ASSIGNMENTS** STEM Integration Project Phase 3 – Lesson Plan
April 28 Research in probability and statistics	Willow Oaks, Room 1000A	**READINGS** STAT: Chapter 8 Highlights of Related Research Part 2 (pp. 154-168) **ASSIGNMENTS** PBA #2 Graphs Galore Reflection

Note: Faculty reserves the right to alter the schedule as necessary, with notification to students.

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 https://catalog.gmu.edu/policies/honor-code-system/).

- Students must follow the university policy for Responsible Use of Computing (see https://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 https://ds.gmu.edu/).

- Students must silence all sound emitting devices 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 https://its.gmu.edu/knowledge-base/blackboard-instructional-technology-support-for-students/.

- For information on student support resources on campus, see https://ctfe.gmu.edu/teaching/student-support-resources-on-campus

Notice of mandatory reporting of sexual assault, interpersonal violence, and stalking:

As a faculty member, I am designated as a "Responsible Employee," and must report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730, or emailing titleix@gmu.edu.

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

Prob/Stat Rich Task Reflection
Course Performance Based Assessment
Reflection Logs 1-4 Rubric

Level/Criteria	4	3	2	1
	Exceeds Expectations	**Meets Expectations**	**Developing**	**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: • 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: • 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: • 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 following elements: • 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 formulate and test conjectures in order to frame generalizations.	The candidate includes all of the following elements: • 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 problem set	The candidate includes two of the following elements: • 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: • 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 following elements: • 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

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REPRESENTATIONS NCTM Element 2.b 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.	The candidate includes all of the following elements: • 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	The candidate includes two of the following elements: • 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	The candidate includes one of the following elements: • 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	The candidate does not include any of following elements: • 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
CONTEXT NCTM Element 2.C Formulate, represent, analyze, and interpret mathematical models derived from real-world contexts of mathematical problems.	The candidate includes all of the following elements: • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation of the solution	The candidate includes two of the following elements: • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation of the solution	The candidate includes one of the following elements: • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation of the solution	The candidate does not include any of following elements: • An example of a similar problem with a different context. • An analysis of a similar problem (compare and contrast) • An interpretation of the solution

NCTM PROCESS STANDARDS **NCTM Element 2.F** 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	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. The reflection includes specific instances where the candidate assisted teachers using all of the following elements: • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/ collections	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. The reflection includes specific instances where the candidate assisted teachers using two of the following elements: • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/ collections	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. The reflection includes specific instances where the candidate assisted teachers using one of the following elements: • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/ collections	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. The reflection does not include any specific instances where the candidate assisted teachers using all of the following elements: • Teacher/Leader discussion groups • Teacher networks • Print, digital, and virtual resources/ collections
PAPER ORGANIZATION	The paper organization includes all of the following: • A cover page with title, author's name, and professional affiliation. • The paper is well-organized, grammatically correct, coherent, and complete. • The paper has distinctive focus and voice. • The paper uses professional language (i.e., no jargon). • The paper is presented in an accessible style. • The paper meets APA formatting guidelines.	The report organization includes five of the following: • A cover page with title, author's name, and professional affiliation. • The paper is well-organized, grammatically correct, coherent, and complete. • The paper has distinctive focus and voice. • The paper uses professional language (i.e., no jargon). • The paper is presented in an accessible style. • The paper meets APA formatting guidelines.	The report organization includes four of the following: • A cover page with title, author's name, and professional affiliation. • The paper is well-organized, grammatically correct, coherent, and complete. • The paper has distinctive focus and voice. • The paper uses professional language (i.e., no jargon). • The paper is presented in an accessible style. • The paper meets APA formatting guidelines.	The report organization includes three or fewer of the following: • A cover page with title, author's name, and professional affiliation. • The paper is well-organized, grammatically correct, coherent, and complete. • The paper has distinctive focus and voice. • The paper uses professional language (i.e., no jargon). • The paper is presented in an accessible style. • The paper meets APA formatting guidelines.

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.

Paper Organization	The paper organization includes all of the following:	The report organization includes five of the following:	The report organization includes four of the following:	The report organization includes three or fewer of the following:
	- A cover page with title, author's name, and professional affiliation. - The paper is well-organized, grammatically correct, coherent, and complete. - The paper has distinctive focus and voice. - The paper uses professional language (i.e., no jargon). - The paper is presented in an accessible style. - The paper meets APA formatting guidelines.	- A cover page with title, author's name, and professional affiliation. - The paper is well-organized, grammatically correct, coherent, and complete. - The paper has distinctive focus and voice. - The paper uses professional language (i.e., no jargon). - The paper is presented in an accessible style. - The paper meets APA formatting guidelines.	- A cover page with title, author's name, and professional affiliation. - The paper is well-organized, grammatically correct, coherent, and complete. - The paper has distinctive focus and voice. - The paper uses professional language (i.e., no jargon). - The paper is presented in an accessible style. - The paper meets APA formatting guidelines.	- A cover page with title, author's name, and professional affiliation. - The paper is well-organized, grammatically correct, coherent, and complete. - The paper has distinctive focus and voice. - The paper uses professional language (i.e., no jargon). - The paper is presented in an accessible style. - The paper meets APA formatting guidelines.