

Minor in Statistics

Program Proposal

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1. Program Summary

Statistics is the science of designing studies or experiments, collecting data, and modeling/analyzing data for the purpose of decision making and scientific discovery. The ability to obtain, analyze and synthesize large amounts of data is key to most research in both the natural sciences and the social sciences. The Statistics minor is designed to encourage students studying in another discipline to gain a deeper understanding of statistics. The program will also prepare students for graduate school and careers in industrial statistics, actuarial science, biostatistics, and research.

The proposed minor in Statistics will consist of three required courses and one elective course. The required courses are MATH 121: Calculus I-- will introduce the theory and applications of differentiation and integration of algebraic and trigonometric functions, MATH 253: Probability, and MATH 353: Statistics -- a calculus-based statistics course which will explore the concepts of

statistical inference. The selective is to allow students to explore other facets of the field, such as ethics or other data related courses in other disciplines.

2. Assessment

The assessment of this program will be done through the Mathematics Convening Group.

2.1. Student Learning Goals and Outcomes

The goals and outcomes are a subset of Math and Data Science major program goals and outcomes. These are the subset that are directly addressed (and assessed) in the courses selected for inclusion in Statistics minor program.

Goal 1: Develop problem solving skills

Outcome 1: Students will demonstrate the ability to solve data-related problems. (MATH 253, MATH 353)

Outcome 2: Students will display a broad range of computational skills. (MATH 121)

Goal 2: Develop communication skills

Outcome 3: Students will communicate statistical findings effectively to any audience. (MATH 353)

Goal 3: Develop technically proficient professionals

Outcome 4: Students will perform basic technical skills to design experiments, collect and prepare data for analysis. (MATH 353)

2.2. Assessment Process, alignment with all-college goals/outcomes, and curriculum map

To showcase how the curriculum is included in the major program, I have aligned the three required courses with the student learning outcomes and the all-college goals/outcomes. Note that CMPS 130 is not used in the major program assessment process, but does support the learning objectives. Thus, an X in Table 1 indicates that a course will be used by the Data Science major for assessing that outcome. Many of the courses address more outcomes than indicated in Table 1, but this showcases the implementation of the assessment plan.

Table 1: Assessment of Minor courses

Course	Outcome 1	Outcome 2	Outcome 3	Outcome 4
MATH 121	X	X	X	X
MATH 253	X	X		
MATH 353	X	X		X
Alignment with All-college goals/outcomes	-Apply methods of scientific inquiry effectively. -Apply mathematical concepts effectively. -Develop the skills necessary to locate, evaluate, and employ information effectively.	-Write effectively in scholarly and creative contexts. -Speak effectively in scholarly and creative contexts. -Use technology to communicate information, manage information, or solve problems.	-Demonstrate logic and reasoning skills. -Use technology to communicate information, manage information, or solve problems.	-Apply methods of scientific inquiry effectively. -Apply mathematical concepts effectively. -Demonstrate logic and reasoning skills. -Develop the skills necessary to locate, evaluate, and employ information effectively. -Use technology to communicate information, manage information, or solve problems.

2.3. Direct Measures

Every outcome will be assessed using direct measures, as indicated in the Mathematics major assessment plan. Direct measures used to determine the level of student achievement include comprehensive reviews of student work. For each outcome, specific coursework will be directly evaluated by faculty in the Mathematics, and/or Data Science disciplines. In the case of courses, a faculty member who is not teaching the course from which the assignment is drawn will be selected to perform the evaluation. The only exception will be for oral presentation evaluations, which will be assessed by the instructor of the course.

3. Alignment with Strategic Plan

The proposed minor program supports the mission and values of Ramapo College through its interdisciplinarity and use of hands-on learning. We also are well aligned with the Colleges' Strategic plan's Objective 3.1.

College Mission: This minor program relates closely to interdisciplinary learning and experiential learning, two of the four pillars of Ramapo College. In addition, the ability to obtain, handle and think critically about data, and to understand the design, and limitations of statistical analysis fit well within a liberal arts education.

College Vision: The proposed minor in Statistics develops proficiency in statistical techniques that can equip students to better navigate our data-driven world. Additionally, the program is offered in computing labs to have hands-on learning experiences in and out of the classroom.

Strategic Plan:

Objective 3.1: To facilitate curricular innovation and to ensure that curriculum remains founded in the liberal arts, relevant, attuned to students' needs, and responsive to the economic environment: Statistics is the science of study design, information gathering, data analysis and decision making. Nearly every discipline at Ramapo has begun to utilize data and computing to various extents, so we look to expand and support that work with a formal minor in statistics. This proposal aims to have a strong computational, applied, and interdisciplinary focus that prepares students to effectively contribute to their area of study and to better understand, improve, and contribute their quota to national development.

TAS mission and/or goals

The Statistic minor program aligns with the mission of TAS in that it prepares its graduates to be scientifically literate citizens and lifetime learners, and it meets the needs of the contemporary marketplace and community.

We highlight two quotes from the TAS mission and explain how the minor program addresses this feature of our mission.

3.1 Impact on other Programs

Course availability:

The minor is composed of existing courses and there should be seats available for these new minor students. All the required courses are in the Mathematics curriculum. The elective courses span through Data Science, Computer Science, Business, Psychology, and Social Work curriculums. This minor program would not compete with any major, but it will likely compete with other existing minors including at least Business Analytics and Mathematics.

4. Program need

4.1 Labor Market Demand

National research groups continue to rank statistics and mathematical sciences related careers as some of the fastest growing, the “best” STEM careers in the nation (CareerCast Rankings 2021)¹. Recently, statisticians were rated the #6 overall best job², the #5 best STEM job³ and the #2 best business jobs⁴ in the nation.

There is a huge gap in the supply and demand for data oriented professionals nationally. It is estimated that approximately 1/3⁵ of all statistics related jobs are filled and many companies settle on under qualified applicants; approximately 43%⁶ of companies report not having or being able to find the personnel for their statistics and data science needs. In addition to the current workforce not meeting current demand, U.S. Bureau of Labor Statistics predicts that statistics jobs will grow 33% by 2030⁷. Among the new job opportunities for statisticians and data related positions, according to the 2017 Quant Crunch report from IBM⁸, 61% of statistical and advanced analyst positions will be available to bachelor's degree holders, while 39% will require a master's or doctoral degree. A minor in Statistics will put graduates in a prime position to fill the employment gaps in the field.

The proposed minor program will be appropriate for students from a variety of backgrounds since it is not rooted in a particular industry and incorporates an experiential educational model to not only prepare our graduates to understand the intellectual side of the field, but also be able to apply their ideas and work collaboratively in research, business and government settings.

¹ CareerCast.com: The Best Jobs of 2021. CareerCast. Accessed 3 October 21 from: <https://www.careercast.com/jobs-rated/best-jobs-2021?page=0>

² U.S. News & World Report: 100 Best Jobs. Accessed 3 October 21 from: <https://money.usnews.com/careers/best-jobs/rankings/the-100-best-jobs>

³ U.S. News & World Report: Best STEM Jobs. Accessed 3 October 21 from: <https://money.usnews.com/careers/best-jobs/rankings/best-stem-jobs>

⁴ U.S. News & World Report: Best Business Jobs. Accessed 3 October 21 from: <https://money.usnews.com/careers/best-jobs/rankings/best-business-jobs>

⁵ Press, G. The Supply And Demand Of Data Scientists: What The Surveys Say. Forbes. Apr 30, 2015. Accessed 24 Sep 21 from: <https://www.forbes.com/sites/gilpress/2015/04/30/the-supply-and-demand-of-data-scientists-what-the-surveys-say/?sh=5207dd916b90>

⁶ Ibid

⁷ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Mathematicians and Statisticians. Accessed 24 Sept 24 21 from: <https://www.bls.gov/ooh/math/mathematicians-and-statisticians.htm>

⁸ THE QUANT CRUNCH: HOW THE DEMAND FOR DATA SCIENCE SKILLS IS DISRUPTING THE JOB MARKET, Burning Glass Technologies 2017. Accessed 24 Sept 21 from: <https://www.ibm.com/downloads/cas/3RL3VXGA>

4.2 Student Demand

A couple of students in the Psychology major expressed interest in a Statistics minor in the past. Among the students who developed serious interest in statistics, several came across some difficulty in seeking a clear curriculum guide to expand their vision on this subject and to prepare for graduate program applications and careers in industry, research and academia.

To assess whether other students will be interested in a Statistics minor at Ramapo College, we conducted a survey in the Fall of 2021. Table 2 provides the top six responses of various student groups at Ramapo College. The numbers in parentheses represent the students who answered the questions. The results showed strong and consistent support among current undergraduate students who volunteered to take the survey. It is very clear that student interest is extremely high and that several current undergraduate students at Ramapo College are excitedly anticipating the creation of this program.

This proposed minor program would then give these students a pathway to explore statistics further in a way that will be highlighted on their transcript.

Table 2: Student Interest in and opinion of the proposed Minor in Statistics at the Ramapo College of New Jersey (Fall 2021).

Course/Group/Major	Percent that Strongly Agree or Agree minor will enhance the quantitative skills and analytical thinking	Percent that Very interested or Interested to enroll in the Statistics minor
Nursing	25.9% (59)	16.5% (21)
Biology	21.5% (49)	20.5% (26)
Computer Science	10.9% (25)	13.4% (17)
Business (Accounting, Marketing, Finance)	15.4% (35)	24.4% (31)
Environmental Science	3.9% (9)	3.9% (5)
Communication	3.5% (8)	2.3% (3)

4.3 Other programs in the area

Table 3 provides comparison programs throughout NJ. We highlight undergraduate programs only, including majors and minors in Statistics. We have seen a growth in minor programs, indicating the need for this proposed program at the undergraduate level.

Table 3: Regional undergraduate programs(Major/Minor) in Statistics

NJ Schools	Program name	Degree
The College of New Jersey	Statistics	Minor
Rutgers-New Brunswick	Statistics	B.S. and minor
New Jersey Institute of Technology	Applied Statistics	B.S. and minor
Monmouth University	Statistics	Minor
Drew University	Statistics	B.S. and minor
William Paterson University	Statistics	Minor
Rowan University	Statistics	Minor
Kean University	Statistics	Minor

5. Student Enrollment

Based on Table 2, it would appear that our minor would be very popular. So, we expect about 10-15 students enrolling in the minor each year. This would mean a **total enrollment of 30-60** in the minor program, considering students often declare a minor in their first or second year.

6. Program Resources

These are all existing courses. There are no additional resources needed to run this program.

7. Degree Requirements

The **16-credit minor** would consist of three required courses (12 credits) that are currently in the Mathematics major program and one elective (4 credits). The proposed structure will provide an introduction to the theory and applications of differentiation and integration of

algebraic and trigonometric functions through the probability course which builds up to MATH 353 course which instructs on concepts of statistical inference. The elective is to allow students the opportunity to explore statistical analysis that is the foundation of the field. By offering students a large list of electives, possibly from their major, we intend for students to integrate data skills within their own field of study. We will encourage students outside of TAS to take this minor program. The intent of having a course that may also be included in their major program, it will provide a pathway to consider this minor.

The other three required courses are a sequence of prerequisite courses building technical skills for the statistics course; i.e., MATH 121 -> MATH 253 -> MATH 353.

Table 4. Minor Degree Requirements (Required)

REQUIRED COURSES (16 credits)		
Course Code	Course Title	Credit Hours
MATH 121	Calculus I	4
MATH 253	Probability (Prereq Change)	4
MATH 353	Statistics	4

Table 5. Minor Degree Requirements Electives Options

Choose one from the list (4 credits)		
Course Code	Course Title	Credit Hours
DATA 101	Introduction to Data Science	4
CMPS 320*	Machine Learning	4
MATH 370*	Applied Statistics	4
ENSC 345/ BIOL 345	Research Design and Stats	4
BADM 225	Management Statistics	4
SWRK 307*	Social Work Research Methods	4
PSYC 242	Statistics	4
NURS 325	Nursing Research & Evidence Based Practice	4

*Course contains prerequisites that are not included in the minor program or general education. The inclusion is to encourage students from these disciplines to consider this minor program, but also illustrate its usefulness of data science in their own field of study.

7.1 Course Descriptions

All courses are existing courses, so these are the published course descriptions from the current College catalog.

Table 6. Course Descriptions

Course Code	Course Title	Course Description
MATH 121	Calculus I	An introduction to the theory and applications of differentiation and integration of algebraic and trigonometric functions. Topics include: limits and continuity, derivatives, differentiation rules, implicit differentiation, related rates, differentials, optimization, Mean Value Theorem, curve sketching, Fundamental Theorem of Calculus, definite and indefinite integrals, the substitution rule, derivatives and integrals involving exponential and logarithmic functions.
MATH 253	Probability	This is a calculus-based probability course. Topics include: axioms of probability, sample spaces, laws of probability, conditional probability, Bayes' Theorem, random variables, discrete and continuous distributions, expected value, variance, covariance, and moment-generating functions, multivariable distributions and functions of a random variable. The course will also include the standard convergence theorems, e.g., the law of large numbers and the central limit theorem.
MATH 353	Statistics	This is a calculus-based statistics course. This course will explore the concepts of statistical inference. Topics include: sampling distribution, confidence intervals, point estimation, sufficient statistics, maximum likelihood method, hypothesis testing, Neyman-Pearson lemma, linear and multiple regression, categorical statistics, nonparametric statistics, and ANOVA.

DATA 101	Introduction to Data Science	This course provides an introduction to data science and analytics through hands on analysis of real-world data. Students will learn strategies for acquiring, processing, and utilizing data to make informed, data-driven decisions using computer based tools. Students learn and use the R programming language to understand these core data science skills.
CMPS 320	Machine Learning	This course provides students a basic understanding of machine learning, along with the software development skills to develop models and integrate machine learning into practical applications. Topics include foundational techniques such as linear and logistic regression, confusion matrix, recall, support vector machines, and other key principles of machine learning.
MATH 370	Applied Statistics	This course is designed to enable students to effectively collect data, describe data, and make appropriate inferences from data. Topics may include formulation of statistical questions, study design, random variables and probability distributions, sampling distributions, inference for means, proportions, and differences of means or proportions, multivariate and nonparametric data techniques, transformation of data, chi-squared tests, and analysis of variance. Students are expected to communicate effectively about statistical results and to use a statistical software package for data analysis.
BADM 225	Management Statistics	A study of statistical theories and techniques commonly used in the analysis of business data. Special emphasis will be placed on descriptive measures, probability theory, estimation techniques and forecasting methods, hypothesis testing, and time series analysis.

<p>ENSC 345/BIOL354.</p>	<p>Research Design & Statistics</p>	<p>This course is designed to introduce students to research approaches and statistical methods that are commonly used by environmental scientists and field/lab biologists. A wide variety of research designs (e. g., completely randomized, randomized block, continuous, tabular), descriptive statistics (central tendency, variability, distribution), and parametric and nonparametric hypothesis tests (chi-square, contingency table, paired sample, unpaired sample, multiple sample, correlation, regression) are examined. Students collect, analyze and interpret their own data, and real examples from the literature are discussed. Proficiency in preparing and interpreting scientific graphs is also emphasized. ENSC 345 / BIOL 354 Research Design and Statistics is a required course for the Environmental Science major, and it can be used to fulfill one of the math requirements for the Biology major or as an elective for the Biology major/minor and the Environmental Science minor. This course is cross listed with BIOL354.</p>
<p>SWRK 307</p>	<p>Social Work Research Methods</p>	<p>This course introduces the principles and methods of basic social work research. The development of both substantive research knowledge and methodological research are highlighted. The ethical conduct of research is taught within the context of social work purposes and values. The formulation of problems for study that address the social needs of diverse groups is emphasized. This course attempts to foster methods of research that promote a systematic examination of current knowledge, service delivery and outcomes, and the need for professional accountability. This course is for Social Work majors only.</p>