NEW PROGRAM PROPOSAL FORM

Sponsoring Institution(s): Truman State University

Program Title: <u>Statistics</u>

Degree/Certificate: <u>Statistics</u>

Options: Not Applicable

Delivery Site(s): <u>Truman State University / Kirksville, MO</u>

CIP Classification: 270501

*CIP code can be cross-referenced with programs offered in your region on MDHE's program inventory <u>highered.mo.gov/ProgramInventory/search.jsp</u>

Implementation Date: Fall 2017

Cooperative Partners: Not Applicable

*If this is a collaborative program, form CL must be included with this proposal

AUTHORIZATION:

Dr. Troy Paino / President

Name/Title of Institutional Officer	Signature	Date

Janet Gooch   (660)785-4248

Person to Contact for More Information	Telephone

Rationale for Addition of a Statistics Major

Truman State University

Summary:
A Bachelor's Degree in Statistics is proposed to support a growing national and state need. This degree will balance a broad liberal arts education with focused study of statistics, including several courses focusing on a concentration within statistics. A successful graduate will be well-prepared for graduate study in statistics and statistics related areas and careers in a variety of industries. Creating this new major will support the needs of current students and also attract more students to Truman.

Audience:
This degree is intended for undergraduate students whose interest is in understanding statistics and its interconnections with other disciplines. Students will be provided a foundation in data collection, modeling, analysis, and critical evaluation. Students with a statistics major with technical knowledge and skills will be ready to pursue graduate study and/or a career in statistics, biostatistics, data science, actuarial science, and other data-analytic fields. Although we believe some students who would already have come to Truman may choose a statistics major, our intent is to attract an audience of new students from Missouri and beyond.

Need:
The proposed Statistics degree meets an emerging need in a quickly growing field. The field of Statistics has continued to grow dramatically due to improvements in technology and the ubiquity of data across disciplines and industries. Studies of the job market indicate that America's higher learning institutions are not producing qualified statisticians fast enough to meet demand. According to an article in *Science Daily*, "Statistics is one of the fastest-growing degrees in the US, but the growth may not be enough to satisfy the high demand for statisticians in technology, consumer products, health care, government, manufacturing and other areas of the economy, an analysis conducted by the American Statistical Association finds.[1]" The state of Missouri projected over a 20% increase in employment for statisticians from 2012 to 2022 according to the Missouri Economic Research and Information Center (MERIC).[2]

The number of Statistics degrees at all education levels – Phd , Master's, and Bachelor's – has dramatically increased in the last 30 years.[3] In particular, the number of Bachelor's degrees in Statistics has almost doubled in the last 10 years. However, this increase has still not met the demand. Therefore, it is expected that the trend will continue.

A campus-wide Truman student survey was conducted to gauge current students' interest in a Statistics major. Truman's Center for Applied Statistics and Evaluation (CASE) designed and administered an online survey, sent out in October 2015, to all current undergraduate students; 671 students responded to the survey, a 12.7% response rate. Among the respondents, 93 current students (13.9%) indicated that they would be interested in a statistics major. Various current majors including, Math, Accounting, Biology, Business Administration, Computer Science, Economics, and Psychology majors indicated they would be interested if Truman offered a Statistics major.

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[1] ASA, October 1, 2015, http://www.sciencedaily.com/releases/2015/10/151001125945.htm
[2] https://www.missourieconomy.org/occupations/occ_proj.stm
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The traditional approach to statistics is theoretical. Its goal is to train specialists in the knowledge of statistics. However, a quality Statistics degree should provide students with a broad knowledge base in the liberal arts and sciences, because statistics is by its very nature interdisciplinary and because it builds on broader skills and goals – including critical thinking, problem solving, written and oral communication, and making the best decisions under uncertain conditions. The essential knowledge and skills learned through the study of statistics can be applied to a variety of disciplines, fields, and careers. Education at a liberal arts and sciences university such as Truman is a perfect fit to make connections across different fields of knowledge and to foster development of liberal arts skills.

For these reasons we will offer **both** Bachelor of Science and Bachelor of Arts degrees in Statistics within the context of a liberal arts and sciences education. Three specialized tracks -- Theoretical Statistics, Applied Statistics, and Data Science -- provide a broad knowledge base in the arts and sciences, technical competence in three different areas of statistics, and the ability to connect these fields of knowledge for practical problem-solving.

A quality Statistics degree should provide students with a broad knowledge base in the liberal arts and sciences, because statistics is by its very nature interdisciplinary and because it builds on broader skills and goals – including critical thinking, problem solving, written and oral communication, and making the best decisions under uncertain conditions. The essential knowledge and skills learned through the study of statistics can be applied to a variety of disciplines, fields, and careers. Education at a liberal arts and sciences university such as Truman is a perfect fit to make connections across different fields of knowledge and to foster development of liberal arts skills.

Building Missouri's future...
by degrees®

STUDENT ENROLLMENT PROJECTIONS

Year	1	2	3	4	5
Full Time	6	12	17	27	32
Part Time	0	0	0	0	0
Total	6	12	17	27	32

*Projections include anticipated enrollments in both BA and BS degree programs.

Please provide a rationale regarding how student enrollment projections were calculated:

We anticipate sufficient demand for this program among current Truman students, as well as from high school students considering college. While it is expected that some current Truman students would like to pursue the degree right away, we expect the major enrollment will gradually increase after a few years, once recruiting efforts begin in earnest. Awareness of data science as a growing career is gradually expanding in the public consciousness. Most university programs, apart from the top 8 institutions, have moderate counts of 5-30 students and new programs are naturally smaller.

Provide a **rationale** for proposing this program, including **evidence of market demand and societal need supported by research**:

The proposed Statistics degree meets an emerging need in a quickly growing field. The field of Statistics has continued to grow due to improvements in technology and the ubiquity of data across disciplines and industries. Studies of the job market indicate that America's higher learning institutions are not producing qualified statisticians fast enough to meet demand. According to an article in *Science Daily*, "Statistics is one of the fastest-growing degrees in the US, but the growth may not be enough to satisfy the high demand for statisticians in technology, consumer products, health care, government, manufacturing and other areas of the economy, an analysis conducted by the American Statistical Association finds." The State of Missouri projected over a 20% increase in employment for statisticians from 2012 to 2022 according to the Missouri Economic Research and Information Center (MERIC).

The number of Statistics degrees at all education levels – PhD, Master's, and Bachelor's – has dramatically increased in the last 30 years as shown in the table and figure below. In particular, the number of Bachelor's degrees in Statistics has almost doubled in the last 10 years. However, this increase has still not met the demand. Therefore, it is expected that the trend will continue.
The Theoretical Statistics concentration will provide a curriculum well-balanced between theory and

application for those considering graduate school in theoretical statistics or biostatistics. This concentration may also be attractive to those considering Actuarial Science, or those who want to double-major or minor in Mathematics, Computer Science, or Economics.

The Applied Statistics concentration would provide a practical and applied curriculum to those planning to work as data analysts, those interested in applied fields like biostatistics, educational measurement, or for those considering minors or double majors in areas including Psychology, Business, Health and Exercise Science, Biology, or Linguistics.

The Data Science concentration would provide an applied and computational curriculum to those considering careers in data science. This concentration is expected to be the most popular considering its growing popularity and demand in industry. The Data Science concentration is unique in Missouri and can attract high school students who would otherwise choose other institutions but are aware of the unique career opportunities emerging in this area. We fully expect that some of these students would consider a double-major or minor in Computer Science.

Table 1—The 10 Universities Granting the Most Bachelor's Degrees in Statistics for 2011–2013

Statistics Bachelor's	2011	2012	2013	2011–2013	2003–2013
University of California, Berkeley	88	99	143	330	689
Purdue University	77	100	135	312	401
University of Illinois at Urbana-Champaign	30	52	67	149	261
University of California, Davis	32	55	53	140	278
University of Minnesota-Twin Cities	28	52	50	130	260
University of Michigan-Ann Arbor	25	29	55	109	267
Miami University-Oxford	39	36	28	103	321
University of California, Los Angeles	20	30	50	100	149
University of Pennsylvania	36	23	33	92	199
University of Florida	30	29	32	91	207
Subtotal	405	505	646	1,556	3,032
Total	1,078	1,345	1,656	4,079	9,279

Statistics and Biostatistics Degrees Awarded in the U.S. by Degree Level
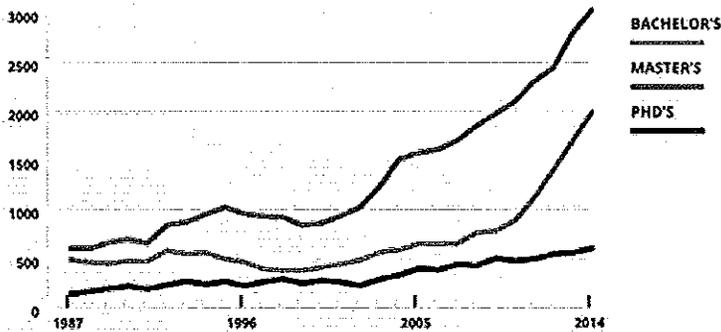
Source: National Center for Education Statistics: Integrated Postsecondary Education Data System

PROGRAM STRUCTURE

A. Total credits required for graduation: <u>120</u>

B. Residency requirements, if any: <u>Normal undergraduate residency requirement applies. The minimum residence requirement is 45 credits hours, 28 of which must immediately precede completion of the requirements for the degree. At least 15 of the 45 credits must be for courses which count toward the student's major requirement. These requirements may be waived only with approval of the Provost.</u>

C. General education: Total credits: <u>63 credit hours are liberal arts and sciences coursework, including the Liberal Studies Program (LSP).</u>

Courses (specific courses OR distribution area and credits):

Course Number	Credits	Course Title
ENG 190	3	Writing as Critical Thinking
COMM 170	3	Public Speaking
Elementary Functions	0-5	The equivalent of Pre-Calculus (may be satisfied by placement)
Statistics	3	Basic Statistics (STAT 190) or Statistics (STAT 290)
Personal Well-Being	2-3	Distribution (LSP)
Aesthetic: Visual & Performing Arts*	3	Distribution (LSP)
Aesthetic: Literature*	3	Distribution (LSP)
Historical*	3	Distribution (LSP)
Philosophical/Religious*	3	Distribution (LSP)
Mathematical**	5	Distribution (LSP)
Scientific: Life Science**	4	Distribution (LSP)
Scientific: Physical Science**	4-5	Distribution (LSP)
Social Scientific**	3-5	Distribution (LSP)
Junior Interdisciplinary Seminar (JINS)	3	Distribution (LSP)
Writing Enhanced	Varies	2 Additional Writing Enhanced Courses (in addition to JINS course)
Intercultural Perspective	0-5	Distribution
Foreign Language	0-8	Distribution
Truman Program	1	
Missouri Statute	1	Distribution

*Must take 3 of 4 Qualitative Modes of Inquiry and **Must take 3 of 4 Quantitative Modes of Inquiry.
All students must complete 63 hours of courses designated as Liberal Arts and Sciences courses (LAS), including the courses above.

D. Major requirements: Total credits: <u>36-43</u>

Course Number	Credits	Course Title
Core (21-22 credit)		
BA/BS requirement*	6	Foreign Language/Math and Science-based courses
One of the following two classes		
MATH 263	5	Calculus II
STAT 260	4	Applied Mathematics for Data Analysis
One of the following two classes		
MATH 285	3	Matrix Algebra
MATH 357	3	Linear Algebra

STAT 101	1	Statistics Freshman Seminar
STAT 250	3	Statistical Computing
STAT 398	1	Statistics Intermediate Seminar
STAT 478	3	Linear Model
STAT 497	2	Capstone Experience
STAT 498	1	Senior Seminar
CS 170	3	Introduction to Computer Science I
Theoretical Statistics (21 credit)		
MATH 200	3	Foundations
MATH 264	3	Calculus III
MATH 461	3	Advanced Calculus
STAT 475	3	Design of Experiments
STAT 570	3	Mathematical Statistics I
STAT 571	3	Mathematical Statistics II
STAT 300+	3	Electives
Applied concentration (15 credit)		
STAT 391	3	Statistical Consulting
STAT 410	3	Probability Models
STAT 300+	6	Electives
STAT 400+	3	Electives
Data Science concentration (21 credit)		
STAT 220	3	Fundamentals of Data Science
STAT 320	3	Data Organization and Visualization
STAT 420	3	Data Mining and Multivariate Statistics
STAT 300+	0-6	Electives
CS 191	3	Computing Structures
CS 430	3	Databases
CS 300+	0-6	Electives

The proposed major requires 21-22 core credits. Theoretical and Data Science require 21 concentration credits, and Applied Statistics requires 15 concentration credits. *Following University policies, the BA degree will require intermediate proficiency in one foreign language, and the BS degree will require 6 additional credits in math or science-based courses.

E. Free elective credits:
14-24
(Sum of C, D, and E should equal A.)

F. Requirements for thesis, internship or other capstone experience:
2 credit, STAT497 Capstone experience

G. Any unique features such as interdepartmental cooperation:
Statistics majors may substitute at most one course from another discipline for an elective. Such a course must be at the 300 level or above, contain a strong statistical component (more than simple data analysis), and be approved by the statistics faculty.

Program Structure (credit hours in parentheses)

The table below shows how required pre-requisites and recommended courses for the major integrate with the fulfillment of requirements for the Liberal Studies program.

		Theoretical Statistics	Applied Statistics	Data Science
LSP (8)	5	MATH 198 Calculus I (5)		
	3	STAT 190 or STAT 290 (3)		
Math Core (7-8)	4-5	MATH 263 Calculus II/ STAT 260 Applied Mathematics for data analysis (4-5)		
	3	MATH 285 Matrix Algebra or MATH 357 Linear Algebra (3)		
Stat Core (6)	3	STAT 250 Statistical Computing (3) prereq - STAT 190		
	3	STAT 478 Linear Model (3) prereq - STAT 190/290, MATH 285/357, STAT 250		
CS Core (3)	3	CS 170 Introduction to Computer Science I (3)		
Seminars and Capstone (5)	1	STAT 101 Statistics Freshman Seminar (Careers, Opportunities, Excel) (1)		
	1	STAT 398 Statistics Intermediate Seminar (Ethics/History/Job Stuff) (1)		
	2	STAT 497 WE/Capstone Experience (Research, Internship, or Project) (2)- waived for double-majors		
	1	STAT 498 Senior Seminar (1)		
Core Cred. total	21-22			
Core Specified Choices		MATH 263 Calc II (5) (1 addl.) MATH 357 Linear Algebra (3) STAT 290 Statistics (3)		
Math		MATH 264 Calc III (3) MATH 200 Foundations (3) MATH 461 Adv Calc (3)		
Additional Required Statistics		STAT 570 Math Stat I (3) STAT 571 Math Stat II (3) STAT 475 Design of Experiments (3)	STAT 391 WE/Statistical Consulting (3) STAT 410 Probability Models (3) OR STAT 570 (3)	STAT 220 Fundamentals of Data Science (3) STAT 320 Data Org/Vis (3) STAT 420 Data Mining & Multivariate Stats (3)
Statistics Electives		300+ STAT elective (3)	300+ STAT electives (6) 400+ STAT electives (3)	300+ STAT/CS electives (6) Bayesian/Big data is strongly recommended
CS				CS 191 Computing Structures (3) CS 430 Databases (3)
Minor/ internship			recommended minor or internship (12+)	recommended internship (12+)
core credits		22	21-22	21-22
concentration credits		21	15	21
Total Size		43 credits (+ 8 in LSP)	36 -37 credits (+ 8 in LSP)	42-43 credits (+ 8 in LSP)
		Theoretical Statistics	Applied Statistics	Data Science

Note: Statistics majors may substitute at most one course from another discipline for an elective. Such a course must be at the 300 level or above, contain a strong statistical component (more than simple data analysis), and be approved by the statistics faculty. A list of approved courses may be obtained in the Statistics Department Office.

PROGRAM CHARACTERISTICS AND PERFORMANCE GOALS

Institution Name   Truman State University
Program Name   Statistics
Date   April 1, 2016

(Although all of the following guidelines may not be applicable to the proposed program, please carefully consider the elements in each area and respond as completely as possible in the format below. Quantification of performance goals should be included wherever possible.)

1. Student Preparation

- Any special admissions procedures or student qualifications required for this program which exceed regular university admissions, standards, e.g., ACT score, completion of core curriculum, portfolio, personal interview, etc. Please note if no special preparation will be required.
  No Special Preparation is required. Any student accepted to Truman would be eligible to declare a major in Statistics.

- Characteristics of a specific population to be served, if applicable.
  Click here to enter text.

2. Faculty Characteristics

- Any special requirements (degree status, training, etc.) for assignment of teaching for this degree/certificate.
  Normal faculty qualifcations, consistent with guidelines from the American Statistical Association and the Higher Learning Commission. Typically instructors will be directly from the field of statistics, but instructors of applied courses could come from applied disciplines (such as business, education, or the social or natural sciences) that heavily use statistical technologies and methodologies.

- Estimated percentage of credit hours that will be assigned to full time faculty. Please use the term "full time faculty" (and not FTE) in your descriptions here.
  It is anticipated that all courses will be taught by full-time faculty with interests in the courses offered. However, the hiring of qualified adjunct faculty may be appropriate (and sometimes even advantageous) from time to time.

- Expectations for professional activities, special student contact, teaching/learning innovation.

Most courses in the statistics program will be taught in a traditional classroom format, but with heavy use of technology. Mathematically-driven statistics courses may be taught in the classroom using traditional mathematics pedagogies with minimal technology. We expect that some courses may be taught using hybrid or online techniques, but not yet at a number warranting approval as an online program.

3. Enrollment Projections

- Student FTE majoring in program by the end of five years.
  We expect to enroll approximately 32 full-time students in the program by the end of five years.

- Percent of full time and part time enrollment by the end of five years.
  It is expected that nearly all statistics majors will be full-time Truman students. Truman welcomes part-time students, but their numbers are limited.

4. Student and Program Outcomes

- Number of graduates per annum at three and five years after implementation.
  6 in year three; 8 in year five.

- Special skills specific to the program.
  The traditional approach to statistics is theoretical. Its goal is to train specialists in the knowledge of statistics. However, a quality Statistics degree should provide students with a broad knowledge base in the liberal arts and sciences, because statistics is by its very nature interdisciplinary and because it builds on broader skills and goals – including critical thinking, problem solving, written and oral communication, and making the best decisions under uncertain conditions. The essential knowledge and skills learned through the study of statistics can be applied to a variety of disciplines, fields, and careers. Education at a liberal arts and sciences university such as Truman is a perfect fit to make connections across different fields of knowledge and to foster development of liberal arts skills. For these reasons we will offer both Bachelor of Science and Bachelor of Arts degrees in Statistics within the context of a liberal arts and sciences education. Three specialized tracks – Theoretical Statistics, Applied Statistics, and Data Science – provide a broad knowledge base in the arts and sciences, technical competence in three different areas of statistics, and the ability to connect these fields of knowledge for practical problem-solving.
  For our majors, the Statistics department holds the following goals:
  • To offer students a unique, liberal arts and sciences-based preparation for graduate study in theoretical statistics and statistically-driven areas such as biostatistics, educational measurement, or data science and/or preparation for employment in entry-level positions in a statistics-related field.
  • To provide graduates with the technical skills to interpret and perform statistical analyses, the ability to use this knowledge for problem solving, and the preparation and attitude necessary

to continue acquiring new knowledge and skills.
- To provide students the knowledge and skills of a liberal education as defined by the mission of Truman State University. Graduates should demonstrate proficiency in basic skills including communication, mathematics, application of science and the scientific method, critical thinking and problem solving, leadership, management, and collaboration.
- To instill values such as ethical behavior, respect for diversity, and desire for life-long learning.

For the non-majors taking Statistics courses, the study of statistics offers rich opportunities to promote the goals of liberal learning. Statistics plays an important role in understanding our global society where data is ubiquitous and statistics bridges disciplinary boundaries in important ways. The Statistics Department, therefore, has identified two goals for non-major students:
- To educate students about data collection, modeling, quantitative analysis, critical evaluation, and ethics in applications of statistics.
- To promote the skills and attitudes associated with a liberal education at Truman State University

A successful Statistics major will achieve the following outcomes.
- Outcome A: Development of statistical knowledge, skills, and attitudes in key areas: A1. Statistical methods and theory; A2. Data manipulation and computation; A3. Mathematical Foundations; A4. Statistical Practice, including work in ethics, communication and collaboration.
- Outcome B: Understanding of the Liberal Arts foundation of the discipline of statistics: B1. Exposure to the history, philosophy, and social movements that led to the development of statistics as its own discipline; B2. Exploration of the connection between the discipline of statistics and the use of statistical methods in a variety of disciplines; B3. Development of Critical Thinking, Problem Solving, and Creative Thinking Skills necessary for a future as an engaged citizen and future leader.
- Outcome C: Completion of in-depth work in at least one concentration: C1. Theoretical Statistics; C2. Applied Statistics; C3. Data Science.

- Proportion of students who will achieve licensing, certification, or registration.
  There is currently no license for bachelor-level statisticians.

- Performance on national and/or local assessments, e.g., percent of students scoring above the 50th percentile on normed tests; percent of students achieving minimal cut-scores on criterion-referenced tests. Include expected results on assessments of general education and on exit assessments in a particular discipline as well as the name of any nationally recognized assessments used.
  Students will be assessed throughout their time in the Statistics Major. The outcomes being accessed are listed in parentheses: 1) Key courses will include signature assignments and or common exam items to be assessed beyond classroom grading at regular intervals (assessing outcomes A4, B1, B2, B3); 2) Student Surveys will be conducted during key courses, including the Freshman and Senior Seminar (assessing all outcomes in A, B, and C); 3) Senior Students will complete a nationally normed assessment, such as the CLA+ (assessing outcome B3); 4) Data from campus-wide instruments such as the Truman portfolio will be examined (assessing outcomes B2, B3); 5) The number of students entering the major and completing key courses in

the major will be tracked (assessing outcomes A1, A2, A3, C1, C2, C3); 6) The Graduation Rate for entering students, including those who switch to a related mathematical science including such as mathematics, computer science, or physics, or a statistically-related field such as business, biology, health science, or psychology will be tracked; 7) The placement rate for students attending graduate school or entering the workforce will be monitored; 8) Alumni and employers will be surveyed (assessed outcomes A1, A2, A3, B1, B2, B3).

- Placement rates in related fields, in other fields, unemployed.
  We would anticipate a placement rate for Statistics graduates of approximately 90%. The proposed degree meets a need for students who may wish to pursue an advanced degree in Statistics or a related field and provides students an opportunity to develop skills that are in high demand by employers. Truman State University is uniquely positioned to offer this degree at an affordable cost that will help students in parts of the state not easily reached by the few existing programs in Statistics. Potential graduate school programs and employers include: Graduate programs in Statistics (University of Missouri-Columbia, Washington University, Saint Louis University, University of Iowa, Iowa State University, University of California-Berkeley, Purdue University–Main Campus, North Carolina State University at Raleigh, University of Michigan-Ann Arbor, University of Illinois at Urbana-Champaign, University of Minnesota-Twin Cities, Carnegie Mellon University, University of Florida, University of Pennsylvania, University of Washington-Seattle Campus, Northwestern University, and more); Statistics-related graduate programs and training areas (Biostatistics, Animal Health, Clinical Trials , Epidemiology, Genetics, Pharmacology, Public Health, Quantitative Psychology, Chemistry, Economics, Actuarial Science, Management Science, Industrial and Systems Engineering, Quality Control, Assessment and Measurement,Six-Sigma Programs, Reliability, Ergonomics, Sports Research, and more); Employers and internships (Boeing, Monsanto, Cerner, Express Scripts, Maritz Research, the Federal Reserve Banks, Caterpillar, US Census Bureau, Bureau of Labor Statistics, a variety of state and federal agencies, Mayo Clinic, hospitals and medical centers, pharmaceutical companies, banks, insurance companies, investment banks and related financial firms and more.). More than 40 different internship sites are listed by the American Statistics Association.

- Transfer rates, continuous study.
  We anticipate that students will not elect to transfer out of the program at rates different from other Truman undergraduate programs.

5. Program Accreditation
- Institutional plans for accreditation, if applicable, including accrediting agency and timeline. **If there are no plans to seek specialized accreditation, please provide a rationale.**
  There are currently no specialized accreditation opportunites (outside of the scope of normal institutional accreditation through HLC) that are applicable to this discipline.

6. Alumni and Employer Survey

- Expected satisfaction rates for alumni, *including timing and method of surveys.*
  Students will be surveyed upon graduation. Alumni and employers will be contacted to complete a survey three and five years out from the completion of the student's coursework. Survey questions will be focused on assessing the applicability of learning to the workplace environment and perceptions of program effectiveness in preparing students for the tasks of the workplace.

- Expected satisfaction rates for employers, including timing and method of surveys.
  We hope to achieve satisfaction rates in excess of 80% in the three and five-year surveys, understanding that response rates on these surveys tend to be fairly low the longer you get out from the program.

7. Institutional Characteristics

- Characteristics demonstrating why your institution is particularly well-equipped to support the program.
  Truman has a strong undergraduate program based on the liberal arts. Truman has had a campus-wide Statistics general education requirement for almost 20 years, so it has had time to build a base of support for statistics, with more faculty in statistics and more campus-wide expertise than expected of a school of our size and mission. Also, Truman is home to several faculty with a particular interest and expertise in Data Science. Truman also has a Data Science graduate certificate and 500-level computer science courses in Data Science that have generated significant interest by advanced computer science students. Contributors in other disciplines, including computer science and health professions are numerous. A significant number of alumni are placed in businesses who benefit from statistical data science skills. Consequently, they provide a consistent source of feedback on employer needs, creating a vital knowledge loop for retooling and improving the curriculum.

ITEM H
Resolution Amending Sections 5.010.1 and 5.010.2 of the Code of Policies of the Board of Governors—Academic Degrees and Academic Programs

RATIONALE FOR ADDITION OF STATISTICS MAJOR

Summary

A Bachelor's Degree in Statistics is proposed to support a growing national and state need. This degree will balance a broad liberal arts education with focused study of statistics, including several courses focusing on a concentration within statistics. A successful graduate will be well-prepared for graduate study in statistics and statistics related areas and careers in a variety of industries. Creating this new major will support the needs of current students and also attract more students to Truman.

Audience

This degree is intended for undergraduate students whose interest is in understanding statistics and its interconnections with other disciplines. Students will be provided a foundation in data collection, modeling, analysis, and critical evaluation. Students with a statistics major with technical knowledge and skills will be ready to pursue graduate study and/or a career in statistics, biostatistics, data science, actuarial science, and other data-analytic fields. Although we believe some students who would already have come to Truman may choose a statistics major, our intent is to attract an audience of new students from Missouri and beyond.

Need

The proposed Statistics degree meets an emerging need in a quickly growing field. The field of Statistics has continued to grow due to improvements in technology and the ubiquity of data across disciplines and industries. Studies of the job market indicate that America's higher learning institutions are not producing qualified statisticians fast enough to meet demand. According to an article in *Science Daily*, "Statistics is one of the fastest-growing degrees in the US, but the growth may not be enough to satisfy the high demand for statisticians in technology, consumer products, health care, government, manufacturing and other areas of the economy, an analysis conducted by the American Statistical Association finds.[1]" The State of Missouri projected over a 20% increase in employment for statisticians from 2012 to 2022 according to the Missouri Economic Research and Information Center (MERIC).[2]

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A quality Statistics degree should provide students with a broad knowledge base in the liberal arts and sciences. Statistics is naturally interdisciplinary and it builds on broader skills and goals including critical thinking, problem solving, written and oral communication, and making the best decisions based on limited information.

We will offer **both** Bachelor of Science and Bachelor of Arts degrees in Statistics within the context of a liberal arts and sciences education. Three specialized tracks are Theoretical Statistics, Applied Statistics, and Data Science.

RECOMMENDED ACTION

BE IT RESOLVED that Section 5.010.1 of the Code of Policies of the Board of Governors of Truman State University entitled <u>Academic Degrees</u> be amended by the addition of the following undergraduate degrees:

BA Statistics
BS Statistics

BE IT RESOLVED that Section 5.010.2 of the Code of Policies of the Board of Governors of Truman State University entitled <u>Academic Programs</u> be amended by the addition of the following undergraduate program; and

Statistics, Bachelor of Arts
Statistics, Bachelor of Science

BE IT FURTHER RESOLVED that the adoption of such degrees/programs be subject to the approval of the Coordinating Board for Higher Education.

Moved by   Jennifer Kopp Dameron
Seconded by   Cheryl J. Cozette
Vote: Aye 7
                 Nay 0

ATTACHMENT

Statistics Major Proposal

Outcomes

The traditional approach to statistics is theoretical. Its goal is to train specialists in the knowledge of statistics. However, a quality Statistics degree should provide students with a broad knowledge base in the liberal arts and sciences, because statistics is by its very nature interdisciplinary and because it builds on broader skills and goals – including critical thinking, problem solving, written and oral communication, and making the best decisions under uncertain conditions. The essential knowledge and skills learned through the study of statistics can be applied to a variety of disciplines, fields, and careers. Education at a liberal arts and sciences university such as Truman is a perfect fit to make connections across different fields of knowledge and to foster development of liberal arts skills. For these reasons we will offer both Bachelor of Science and Bachelor of Arts degrees in Statistics within the context of a liberal arts and sciences education. Three specialized tracks – Theoretical Statistics, Applied Statistics, and Data Science – provide a broad knowledge base in the arts and sciences, technical competence in three different areas of statistics, and the ability to connect these fields of knowledge for practical problem-solving.

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- To offer students a unique, liberal arts and sciences-based preparation for graduate study in theoretical statistics and statistically-driven areas such as biostatistics, educational measurement, or data science and/or preparation for employment in entry-level positions in a statistics-related field.
- To provide graduates with the technical skills to interpret and perform statistical analyses, the ability to use this knowledge for problem solving, and the preparation and attitude necessary to continue acquiring new knowledge and skills.
- To provide students the knowledge and skills of a liberal education as defined by the mission of Truman State University. Graduates should demonstrate proficiency in basic skills including communication, mathematics, application of science and the scientific method, critical thinking and problem solving, leadership, management, and collaboration.
- To instill values such as ethical behavior, respect for diversity, and desire for life-long learning. For the non-majors taking Statistics courses, the study of statistics offers rich opportunities to promote the goals of liberal learning.

Statistics plays an important role in understanding our global society where data are ubiquitous and statistics bridges disciplinary boundaries in important ways.

The Statistics Department, therefore, has identified two goals for non-major students:

- To educate students about data collection, modeling, quantitative analysis, critical evaluation, and ethics in applications of statistics.
- To promote the skills and attitudes associated with a liberal education at Truman State University.

A successful Statistics major will achieve the following outcomes.

- **Outcome A: Development of statistical knowledge, skills, and attitudes in key areas:**
  - A1. Statistical methods and theory;
  - A2. Data manipulation and computation;

- o A3. Mathematical Foundations;
- o A4. Statistical Practice, including work in ethics, communication and collaboration.
- **Outcome B: Understanding of the Liberal Arts foundation of the discipline of statistics:**
  - o B1. Exposure to the history, philosophy, and social movements that led to the development of statistics as its own discipline;
  - o B2. Exploration of the connection between the discipline of statistics and the use of statistical methods in a variety of disciplines;
  - o B3. Development of Critical Thinking, Problem Solving, and Creative Thinking Skills necessary for a future as an engaged citizen and future leader.
- **Outcome C: Completion of in-depth work in at least one concentration:**
  - o C1. Theoretical Statistics;
  - o C2. Applied Statistics;
  - o C3. Data Science.

Course Descriptions

Course Descriptions for Major Program

STAT 101 – Freshman Seminar (1 Credit)

Orientation to the university experience and foundations for success in the study of statistics with emphasis on academic planning, goal setting, and problem solving.

STAT 190 – Basis Statistics (3 Credits)

An introduction to descriptive and inferential statistics with practical applications. A student who has completed STAT 290 – Statistics may subsequently enroll in STAT 190, counting both grades in grade point average, but receiving credit toward graduation only for STAT 190.

STAT 220 – Foundations of Data Science (3 Credits)

A broad introduction to the fast-growing field of data science within the broader context of statistics including Data Handling, Visualization, Reproducibility, Predictive Modeling, and Machine Learning. It will investigate the advantages and boundaries of traditional statistical inference, why traditional statistical inference techniques are sometimes not enough, and differences in rhetorical and philosophical models between the two. Ethical issues in analytics and related areas (big data, genomics, etc.) will be discussed throughout. Some sections may be offered in a hybrid setting.

STAT 250 – Statistical Computing (3 Credits)

The course covers practical issues in statistical computing including reading data, data manipulation, accessing packages, writing functions, running and interpreting data analysis, and programming in R. Other statistical software such as Minitab, SPSS, and SAS may also be discussed.

STAT 290 – Statistics (3 Credits)

An introduction to descriptive and inferential statistics with practical applications and an introduction to probability including both discrete and continuous models.

STAT 260 – Applied Mathematics for Data Analysis (4 Credits)

This course will cover mathematical topics and applications necessary for students pursing a major in Statistics. Topics will include basic integration techniques, applications of integration related to probability and statistics, an introduction to differential equations, infinite sequences and series, an introduction to vectors and functions of several variables, partial derivatives, multiple integrals, and applications.

STAT 320 – Data Organization and Visualization (3 Credits)

An exploration of the visual display of complex data using technology. Students will explore multiple ways of providing insight and understanding through static and interactive visualizations, focusing on the needs of expected viewers. Students will create an electronic document or portfolio demonstrating course knowledge, skills, and attitudes.

STAT 391 – Statistical Consulting (3 Credits)

A broad introduction to the intersection of statistics with real world data issues, including collecting, cleaning, and maintaining data, ethical issues and working with clients from a variety of backgrounds. Students will develop statistical communication skills, including writing, public speaking, and working with clients. Through individual and/or group projects, models, and papers, students will grow in their scientific writing abilities.

Students are recommended to have completed or be enrolled concurrently in a statistical methods course, such as STAT 375, STAT 376, STAT 378, STAT 475, or STAT 478.

STAT 398 – Intermediate Seminar in Statistics (1 Credit)

Special topics including ethics, history, written and oral communication, graduate school opportunities, career opportunities, and the role of alumnus/alumna.

STAT 410 – Probability Models (3 Credits)

An introduction to discrete and continuous probability and probability models, including conditional probability, expectation, common discrete and continuous distributions, Poisson processes and discrete Markov chains. Additional topics may come from continuous-time Markov chains, queueing theory, and other applications.

STAT 420 – Multivariate Statistics and Data Mining (3 Credits)

An exploration of techniques used for massive data sets, with an emphasis on the connection between the areas of data mining and multivariate statistics.

STAT 430 – Bayesian / Big Data

The course covers the fundamental concepts of Bayesian methods including Bayes Rule, MCMC, Hierarchical modeling, Bayes factor, and assessment.

STAT 475 – Design Experiments (3 Credits)

Introduction to the theory and the application of Design of Experiments. Topics will include completely randomized designs, factorial designs, randomized blocks, Latin squares, random effects, split plot, and analysis of covariance.

STAT 478 – Regression Analysis (3 Credits)

Simple and multiple linear regression theory and applications, including matrix formation, estimation, and inference, validation of assumptions, model building, and time series.

STAT 497 – Capstone (3 Credits)

A culminating experience in which the student demonstrates skills and knowledge garnered from his or her experience with the Statistics program. Students complete a major project that synthesizes new work with previous coursework in statistics and other courses.

STAT 498 – Senior Seminar (1 Credit)

This seminar provides students the opportunity to see how the major fits into a cohesive whole and be introduced to statistical themes not encountered in previous courses of study. Topics could include using statistical communication, statistical heroes, ethical versus unethical studies, and statistical software packages.

STAT 570 – Mathematical Probability and Statistics I (3 Credits)

Mathematical development of discrete and continuous distributions, expected values, moments, and measures of dispersion.

STAT 571 – Mathematical Probability and Statistics II (3 Credits)

Large and small sampling theory, correction analysis, tests and hypotheses, and other aspects of statistical inference.

Proposed Catalog Copy for the Statistics Major

Text for Bachelor of Arts

MISSION OF THE STATISTICS DEPARTMENT

The mission of the Statistics Department is to provide every student a foundation in data collection, modeling, analysis, and critical evaluation. Additionally, the department provides the foundation students need to pursue graduate study and/or a career in statistics, biostatistics, data science, actuarial science, and other data-analytic fields.

THE MAJOR

A statistics degree provides a foundation into the world of statistics: the study of the collection, analysis, interpretation, presentation, and understanding of data. Grounded in the liberal arts, statistics builds on a base of mathematics and computer science to solve real world problems across disciplinary boundaries.

The major has three concentrations that allow a student to prepare for a variety of future paths.

a.   Theoretical Statistics prepares students for graduate work in statistics or for positions in mathematically-intensive areas of statistics.
b.   Applied Statistics prepares students for work and further study in statistically-driven professions in Biostatistics, Educational Measurement, and similar areas.
c.   Data Science prepares students to make meaning from complex data sets for work in computationally-rich fields.

Graduates in all concentrations should be well-qualified for advanced study in graduate programs or employment in a professional career requiring preparation. All statistics graduates will obtain a background in statistical theory, gain experience with statistical computing and data manipulation, and learn valuable problem-solving, technical writing, and effective communication skills.

Truman's Statistics degree is consistent with the principles and recommendations contained in the American Statistical Association's "Curriculum Guidelines for Undergraduate Programs in Statistical Science," http://www.amstat.org/education/curriculumguidelines.cfm.

DEPARTMENTAL HONORS IN STATISTICS

Honors in Statistics may be earned by:

1.   Maintaining an overall grade point average of 3.5,
2.   Maintaining a major grade point average of 3.5,
3.   Scoring at or above the 80th percentile on the senior exam,
4.   Demonstrating excellence in scholarship by producing a scholarly paper or project, and
5.   Receiving the concurrence of the statistics faculty.

DEGREE REQUIREMENTS

Liberal Studies Program Requirements: **31-57 Credits**
Missouri Statute Requirements: **1-3 Credits**
Bachelor of Arts Requirements: **0-6 Credits**
  - Intermediate proficiency in ONE foreign language

MAJOR REQUIREMENTS (28-30 Credits Plus a Concentration)

The Statistics major consists of three (3) parts: Required Support, Core Major Requirements, and a Concentration. Each student must complete all parts.

Part I - Required Support: 8 Credits

  - STAT 190 - Basic Statistics Credits: 3 OR
    - STAT 290 - Statistics Credits: 3
  - MATH 198 - Analytic Geometry and Calculus I Credits: 5

Courses listed in Required Support may double count for LSP, minor, or other campus requirements, but may not double count with requirements listed elsewhere in this major. Students should work with their advisor to pick the right combination for their concentration requirements and future goals.

Part II - Core Requirements: 22-23 Credits

  - MATH 263 - Analytic Geometry and Calculus II Credits: 5 OR
    - STAT 260 - Applied Mathematics for Data Analysis *(New course)* Credits: 4
  - MATH 285 - Matrix Algebra Credits: 3 OR
    - MATH 357 - Linear Algebra Credits: 3
  - CS 170 - Introduction to Computer Science I Credits: 3 OR
    - CS 180 - Foundations of Computer Science I Credits: 3
  - STAT 101 - Freshman Seminar Credits: 1 *(New Course)*
  - STAT 250 - Statistical Computing Credits: 3 *(New Course)*
  - STAT 398 - Intermediate Seminar in Statistics Credits: 1 *(New Course)*
  - STAT 478 - Regression Analysis Credits: 3 *(New Course)*
  - STAT 497 - Capstone Experience Credits: 3 *(New Course)*
  - STAT 498 - Senior Seminar Credits: 1 *(New Course)*

Part III - Concentration   (15-21 credits) Complete One

<u>**Theoretical Statistics:**</u> (21 credits in concentration)

Students in this concentration must select STAT 290, MATH 263 and MATH 357 as their options within Required Support and Core requirements.

  - MATH 200 - Foundations of Mathematics Credits: 3
  - MATH 264 - Analytic Geometry and Calculus III Credits: 3

- MATH 461 - Advanced Calculus Credits: 3
- STAT 475 - Design of Experiments Credits: 3 *(New Course)*
- STAT 570 - Mathematical Probability and Statistics I Credits: 3
- STAT 571 - Mathematical Probability and Statistics II Credits: 3
- 3 credits from STAT 300+ not counted elsewhere in the core or this concentration

Applied Statistics: (15 credits in concentration)

Students in this concentration are strongly encouraged to complete an internship or minor.

- STAT 391 - Statistical Consulting Credits: 3 *(New Course)*
- STAT 410 - Probability Models Credits: 3 *(New Course)* OR
  - STAT 570 - Mathematical Probability and Statistics I Credits: 3
- 6 credits from STAT 300+ not counted elsewhere in the core or this concentration.
- 3 credits from STAT 400+ not counted elsewhere in the core or this concentration.

Data Science: (18 credits in concentration)

Students in this concentration are strongly encouraged to complete an internship.

- CS 191 - Computing Structures Credits: 3
- CS 430 - Database Systems Credits: 3
- STAT 220 - Foundations of Data Science Credits: 3
- STAT 320 - Data Organization and Visualization Credits: 3 *(New Course)*
- STAT 420 - Multivariate Statistics and Data Mining Credits: 3 *(New Course)*
- 3 credits from CS 300+ courses or STAT 300+ courses not counted elsewhere in the major
  - STAT 430, Bayesian/Big data is strongly recommended

Note:

Statistics majors may substitute at most one course from another discipline for an elective. Such a course must be at the 300 level or above, contain a strong statistical component (more than simple data analysis), and be approved by the statistics faculty. A list of approved courses may be obtained in the Statistics Department Office.

Transfer students majoring in statistics must complete 18 credits in the major at Truman. This coursework must include 15 credits at the 300 level or higher.

Capstone Experience for Statistics

Students who complete an internship experience, complete an intensive research experience, or who complete a statistically-intensive capstone experience as part of a second major, may request that experience to substitute for STAT 497. All students must complete STAT 498.

Text for Bachelor of Science

MISSION OF THE STATISTICS DEPARTMENT

The mission of the Statistics Department is to provide every student a foundation in data collection, modeling, analysis, and critical evaluation. Additionally, the department provides the foundation students need to pursue graduate study and/or a career in statistics, biostatistics, data science, actuarial science, and other data-analytic fields.

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5.   Receiving the concurrence of the statistics faculty.

DEGREE REQUIREMENTS

Liberal Studies Program Requirements:	**31-57 Credits**
Missouri Statute Requirements:	**1-3 Credits**
Bachelor of Science Requirements:	**6 or More Credits**

At least six credits of quantitative or formal reasoning-based coursework from biology, computer science, economics, health and exercise science, mathematics, or psychology. Coursework from other statistically-related areas (health science, linguistics, logic, nursing, sociology, etc.) may count with permission of a student's academic advisor and the Statistics Department chair. Courses in mathematics and/or computer science are recommended for students considering graduate school in statistics. Courses used to fulfill this BS requirement may not be used to satisfy Statistics Major requirements or any Liberal Studies Program component.

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