Statistics - BS
2017 - 2018 Assessment Plan

Currently status is: Report Accepted

I. ANNUAL REPORT FOR 2016 - 2017

Mission Statement

The professors, instructors, and undergraduate advisors in the Department of Statistics serve society by: (1) providing high quality education and training in statistics, (2) extending the frontiers of the discipline through research, and (3) expanding the awareness and usefulness of the discipline through public service. We strive for continual improvement in these areas. In everything we do, we conduct ourselves with openness, enthusiasm, integrity, and respect for the individual and society.

The undergraduate program seeks to support this mission by offering a high-quality undergraduate educational experience to students majoring in statistics. Successful completion of the program will provide students with a balanced program in data analysis, statistical methodology, and the theory of statistics, preparing them to contribute to society as professional statisticians, or providing a foundation for post-graduate study.

Goal 1.

The Department expects all graduates to possess a broad basis in mathematical and applied aspects of statistical practice.

Curriculum

Undergraduate majors are required to complete MATH 141-142 (Calculus I-II), MATH 241 (Vector Calculus) or MATH 250 (Vector Analysis I), and MATH 544 (Linear Algebra) or MATH 526 (Numerical Linear Algebra) for calculus and post-calculus knowledge. Undergraduate majors are also required to complete STAT 511-513 (a three semester sequence in mathematical statistics), STAT 515-516 (Statistical Methods I-II; students may substitute STAT 509 for STAT 515), and a selection of 9 additional semester hours of coursework in advanced statistical applications (at the 500 level).

Learning Outcome 1.

Students will demonstrate the ability to perform fundamental statistical analyses and to prepare informative graphics for public presentation.

Measures and Criteria

B.S. students should successfully demonstrate mastery of the material in the two-semester sequence STAT 515-516. This sequence teaches the applications and principles of descriptive statistics, elementary probability, sampling distributions, estimation and hypothesis testing for means, variances, and proportions, simple and multiple linear regression, analysis of variance for basic designs, and analysis of covariance.

Methods

Success in meeting this learning outcome is evaluated in the spring of every third year (including 2017) based on information collected during the three previous calendar years. The primary piece of information for the evaluation is the students' demonstration of this knowledge through exams and coursework, supplemented by the students' impressions of their knowledge as evaluated by the undergraduate student exit survey, and additional comments solicited from instructors of the statistics elective courses.

The professor(s) of STAT 515-516 in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committe) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

The Assessment Coordinator will prepare a summary of student responses to the exit survey questions: "How do you assess your ability to analyze data?" and "How do you assess your ability to use graphical displays to portray information from a statistical analysis?" S/he will also solicit comments on any perceived weaknesses in this area from instructors of undergraduate elective courses in the department.

These results will be presented to the department's Undergraduate Committee during the spring of the assessment year. This committee will prepare a report on the findings, along with initial suggestions for further refinement or improvement of the program (if necessary). The committee report will be presented to the entire department as an agenda item at the annual department retreat that May, with implementation of any recommended changes beginning that summer and fall.

Results

The grades of statistics B.S. students in the applied statistics courses (STAT 515/516) for Fall 2016 and Spring 2017 were solid overall. In Fall 2016, statistics majors in STAT 515 earned 10 A's, 1 B+, 3 B's, and 1 F. In Spring 2017, statistics majors in STAT 515 earned 2 A's, 2 B+'s, 2 B's, 1 C+, and 1 W. These STAT 515 results were at least as good as the overall grades of the overall STAT 515 audience. In Spring 2017, statistics majors in STAT 516 earned 14 A's, 4 B+'s, and 1 B. This performance by statistics majors was better than average, relative to the overall STAT 516 audience.

STAT 515 teachers for Fall 2016 and Spring 2017 noted that statistics majors seemed to be progressing well and have similar strengths and weaknesses as the general class audience. Specifically, they did well on the earlier, more basic parts of the course, but struggled more on the more complicated parts of the course. Calculating the power of a hypothesis test was a particularly difficult topic. The STAT 516 teacher noted that most statistics majors tended to fall in the top 10% of the class in terms of effort and overall performance.

To gauge the opinions of our undergraduate majors, the undergraduate director implemented a survey using SurveyMonkey.com. The survey was anonymous; it did ask two demographic-type questions (related to year in school, and which courses from a provided list they had taken). Students assessed their own facility in several key areas, rating themselves excellent, competent, or not yet competent. There was a chance for free-response comments about the undergraduate program as well.

As of May 30, 2017, 23 students have filled out the survey (this was a volunteer sample, so caveat emptor). Of the respondents, there were 2 freshmen, 4 sophomores, 3 juniors, 9 seniors, and 5 who had already graduated.

In assessing their own ability to "analyze data", 7 rated themselves excellent, and 15 rated themselves competent. Only 1 rated himself or herself not yet competent. So 22/23 = 96% rated themselves at least competent at this.

In assessing their own ability to "use graphical displays to portray information from a statistical analysis", 7 rated themselves excellent, and 13 rated themselves competent. Only 3 rated themselves not yet competent. So 20/23 = 87% rated themselves at least competent at this.

In the free-response section, student comments included the following ideas:
* One student felt the distributed learning classes were harder to learn from and keep up with.
* Several students preferred more real-life applications, projects, and presentations, and less theoretical work.
* One student would prefer more analytics-oriented classes, including languages like SQL.
* One student wanted more collaboration with the business school to make it easier to sign up for business classes needed for the Risk Management/Insurance minor in the actuarial science concentration.

Use of Results

Part of the issue is of course that the later topics are inherently more difficult. But at least one professor thought that the students got overconfident from the early, easier material, and dialed back their effort level for the rest of the course. Perhaps something like in-class quizzes to encourage course attendance could remedy that tendency.

Ideas for addressing the broad comments about the statistics program offered by the surveyed students include possibly developing a data science concentration in the major that would require more programming and applied courses and fewer theory courses. We would have to be careful about this though, since proper use of analytics requires some knowledge of probability and mathematical statistics.

We could certainly improve our already good relationship with the business school, and we could better communicate (through advising) strategies for students to get into business courses they need for their minors and concentrations.

Timetable:

Task: Discuss possibility of developing data science concentration within the statistics major.

Persons responsible: Undergraduate committee, under the leadership of the undergraduate director, and in consultation with the statistics faculty.

Deadline: Have a decision and plan by April 2018.

Task: Discuss with business school representatives possible adjustments to registration policies for business minors and those with actuarial concentration.

Persons responsible: Undergraduate director.

Deadline: October 2017.

Task: Discuss strategies for better advising actuarial students about options for registration for business classes.

Persons responsible: Undergraduate committee, under the leadership of the undergraduate director.

Deadline: September 2017.

Learning Outcome 2.

Students will demonstrate a mastery of probability and mathematical statistics at the mathematical level of calculus and linear algebra.

Measures and Criteria

B.S. students should successfully demonstrate mastery of the material in the three-semester sequence STAT 511-513. This sequence covers probability, calculus/linear algebra-based mathematical statistics, and applications of this theory.

Methods

Success in meeting this learning outcome is evaluated every third year (including the academic year 2018) based on information collected during the three previous calendar years. The primary piece of information for the evaluation is the students' demonstration of this knowledge through exams and coursework, supplemented by the students' impressions of their knowledge as evaluated by the undergraduate student exit survey, and additional comments solicited from instructors of the statistics elective courses.

The professor(s) of STAT 511-512-513 in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committe) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

The Assessment Coordinator will prepare a summary of student responses to the exit survey question: "How do you assess your ability to apply calculus, linear algebra, and statistical theory to solve 'real-life' problems in statistics?" S/he will also solicit comments on any perceived weaknesses in this area from instructors of undergraduate elective courses in the department.

These results will be presented to the department's Undergraduate Committee during the spring of the assessment year. This committee will prepare a report on the findings, along with initial suggestions for further refinement or improvement of the program (if necessary). The committee report will be presented to the entire department as an agenda item at the annual department retreat that May, with implementation of any recommended changes beginning that summer and fall.

Results

The STAT 511/512 instructor for Fall 2016 and Spring 2017 noted that some statistics majors lacked the facility with calculus to be very successful in these probability and mathematical statistics courses. Some also were unprepared in general for taking a theoretical, highly mathematical course. They seemed to underestimate the amount of time they would have to spend practicing outside of class. They did this during the exam week, but for some this "cramming" was too late. The students were strongly motivated, attended class regularly, and paid attention well. The (separate) STAT 513 instructor for Fall 2016 noted overall good results, but weaknesses on the second test, which invoved deriving hypothesis tests, a very math-heavy topic with lots of manipulations involving algebra, exponents/logarithms, and calculus. The other weak point noted was a derivation of a least-squares estimator in a non-standard model.

The grades of statistics B.S. students in the theoretical statistics courses (STAT 511/512/513) for Fall 2016 and Spring 2017 were mixed overall. In Fall 2016, statistics majors in STAT 511 earned 7 A's, 3 B+'s, 1 C, 2 D+'s, and 2 F's. In Spring 2017, statistics majors in STAT 511 earned 1 B, 1 C, 1 D, and 1 W. The grades in the Spring section were a little weaker, which could be for a couple of reasons: (1) The spring section was taught by the math department, and (2) the ideal progression had statistics majors taking STAT 511 in fall, so we try to advise that sequencing; the ones who took the spring section may have been weaker students or late transfers to the statistics major. In Spring 2017, statistics majors in STAT 512 earned 4 A's, 3 B+'s, 3 B's, 3 C's, 1 F, and 1 W. In Fall 2016, statistics majors in STAT 513 earned 9 A's, 1 B+, and 2 B's. For both of these courses, these results were in line with the outcomes for the general class audience.

In assessing their own ability to "apply calculus, linear algebra, and statistical theory to solve 'real-life' problems in statistics", 7 rated themselves excellent, 8 rated themselves competent, and 8 rated themselves not yet competent. So 15/23 = 65% rated themselves at least competent at this. It should be noted that only 78% of the respondents had taken STAT 511, the first course of the theoretical sequence, yet. Only 39% of the respondents had finished the 511-512-513 sequence. So to some degree the lower scores on this are mitigated by the fact that some students had not yet been trained in this area.

Use of Results

The percentage of students rating themselves at least competent at using calculus and linear algebra to solve real-life problems was the lowest among the four areas the survey asked about. A goal is to improve this percentage in the future, which goes hand-in-hand with possible strategies to improve the success of the STAT 511-512-513 sequence.

Remedies for the calculus weakness and overall lack of mathematical maturity are difficult to come by in practice. As the STAT 511 instructor noted, there is not really time in the STAT 511 course to reteach calculus to the students. We do require passing 3 semesters of calculus with a C or better. This could be changed in the future to requiring a B or better in these calculus courses, but this would have the drawback of preventing a significant number of students from attaining the statistics degree. Another issue is that we allow students to take the third calculus course (MATH 241) simultaneously with the STAT 511 course. This helps the strong students get through the statistical theory sequence relatively early, but it could cause unforeseen problems for weaker students. For example, a student could pass MATH 141 and 142 with C's, and then, simultaneously with taking STAT 511, get an F in MATH 241. Clearly such a student would have little chance of success in STAT 511. Perhaps in the future we could look into making MATH 241 a corequisite (rather than prequisite) for STAT 511 only for those students who earned B's or better in MATH 141 and 142.

A good goal for 2017-2018 is to examine the backgrounds of the students who did poorly in STAT 511. When did these students take calculus, and what were their calculus grades?

Timetable:

Task: Investigate the connection between calculus preparation/grades, and success (or lack thereof) in the STAT 511-512-513 sequence. Use available data and statistical methods to come up with data-based conclusions.

Persons responsible: Undergraduate committee, under the leadership of the undergraduate director.

Deadline: January 2018.

Goal 2.
The Department expects all graduates to possess the necessary background for employment as a statistician in business, industry, or government.

Curriculum
In addition to the core statistical methods and applications courses, undergraduate majors are required to complete STAT 517 (Computing in Statistics), CSCE 145 (Algorithmic Design I) or CSCE 206 (Scientific Applications Programming), and ENGL 462 (Technical Writing) or ENGL 463 (Business Writing).

Learning Outcome 1.

Students will demonstrate the ability to use statistical programming languages.

Measures and Criteria

B.S. students should successfully demonstrate mastery of the material in STAT 540. This course teaches statistical programming languages. Students should also demonstrate knowledge of statistical programming needed to perform the statistical analyses in STAT 515, 516, and the various applied elective courses, including STAT 541.

Methods

Success in meeting this learning outcome is evaluated every third year (including 2019) based on information collected during the three previous calendar years. The primary piece of information for the evaluation is the students' demonstration of this knowledge through exams and coursework, supplemented by the students' impressions of their knowledge as evaluated by the undergraduate student exit survey, and additional comments solicited from instructors of the statistics elective courses.

The professor(s) of each of the applied STAT 500-level courses in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committee, four different rubrics: 515, 540, 541, and the other applied courses) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

The Assessment Coordinator will prepare a summary of student responses to the exit survey question: How do you assess your ability to use statistical programming languages?

These results will be presented to the department's Undergraduate Committee during the spring of the assessment year. This committee will prepare a report on the findings, along with initial suggestions for further refinement or improvement of the program (if necessary). The committee report will be presented to the entire department as an agenda item at the annual department retreat that May, with implementation of any recommended changes beginning that summer and fall.

Results

To gauge the opinions of our undergraduate majors, the undergraduate director implemented a survey using SurveyMonkey.com. The survey was anonymous; it did ask two demographic-type questions (related to year in school, and which courses from a provided list they had taken). Students assessed their own facility in several key areas, rating themselves excellent, competent, or not yet competent. There was a chance for free-response comments about the undergraduate program as well.

As of May 30, 2017, 23 students have filled out the survey (this was a volunteer sample, so caveat emptor). Of the respondents, there were 2 freshmen, 4 sophomores, 3 juniors, 9 seniors, and 5 who had

already graduated.

In assessing their own ability to "use statistical programming languages", 5 rated themselves excellent, 13 rated themselves competent, and 4 rated themselves not yet competent. So 18/22 = 82% rated themselves at least competent at this. 65% of the respondents had taken our main statistical programming course, STAT 540. Others may have gained competence through their use of programming in their applied classes.

Use of Results

The survey data indicates a comfort level with programming languages on the part of the students, but it is questionable whether the students had in mind truly writing original programs, or simply using statistical software for basic analyses.

We plan to study the effectiveness of STAT 540 and STAT 541 more in the future. At this point we believe our requirements for programming are appropriate, but in the future they may require being expanded. The new elective course STAT 587 (= CSCE 587) could be a good way for statistics majors to get more practical experience writing computer programs.

Timetable

Task: Study performance in STAT 540 and STAT 541. Assess whether students who have taken STAT 587 do any better in computing than other students.

Persons responsible: Undergraduate committee, under the leadership of the undergraduate director.

Deadline: May 2019

Learning Outcome 2.

Students will demonstrate competency in technical writing and presentation.

Measures and Criteria

B.S. students should demonstrate the ability to interpret statistical results and explain them effectively using written and/or verbal communication in STAT 515-516 and the various elective courses. Students should also demonstrate mastery of the material in ENGL 462 or ENGL 463.

Methods

Success in meeting this learning outcome is evaluated in the spring of every third year (including 2018) based on information collected during the three previous calendar years. The primary piece of information for the evaluation is the students' demonstration of this capability through projects and presentations that are commonly assigned in the various 500-level STAT courses.

Each year, the professor of each course that assigns a written project or presentation shall will be given a list of undergraduate STAT majors in that section and a copy of the rubric (currently in preparation by the department's undergraduate committee) to guide them in preparing a written summary of the strengths and weaknesses of that cohort of students, including particular examples. They will be reminded of the need to do this throughout each semester by the Assessment Coordinator.

The Assessment Coordinator will prepare a summary of student responses to the exit survey question: How do you assess your ability to explain statistical results? The Assessment Coordinator will also compile a list of grades for the ENGL requirement and use this as supplementary data.

These results will be presented to the department's Undergraduate Committee during the spring of the assessment year. This committee will prepare a report on the findings, along with initial suggestions for further refinement or improvement of the program (if necessary). The committee report will be presented to the entire department as an agenda item at the annual department retreat that May, with implementation of any recommended changes beginning that summer and fall.

Results

The STAT 530 instructor assigned written projects as a major part of the course. The performance of the statistics majors in the class, on average, on these projects was a little lower than the performance of the

rest of the class. However, most of the others in the class were graduate students, so that is a bit of an unfair comparison: What this says is that on average, undergraduate statistics majors appear to be somewhat weaker at writing reports than graduate students in statistics and other fields. Still, based on the performance in the class, there is room for improvement in developing formal writing skills.

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As of May 30, 2017, 23 students have filled out the survey (this was a volunteer sample, so caveat emptor). Of the respondents, there were 2 freshmen, 4 sophomores, 3 juniors, 9 seniors, and 5 who had already graduated.

In assessing their own ability to "explain statistical results", 16 rated themselves excellent, and 7 rated themselves competent. No one rated themselves not yet competent. So 23/23 = 100% rated themselves at least competent at this. 57% of the respondents had taken ENGL 462 or 463 yet; whether these writing classes contributed to their ability to explain statistical results is up in the air. One respondent claimed that taking Business Writing (ENGL 463) was a waste of time, since "the only thing you learn is how to write letters".

Use of Results

One suggestion is to have more major courses require written reports, in the hope that through practice, the students' writing skills will improve. However, time constraints in some courses could make this difficult. And it could be argued that requiring more written project reports will only lead to receiving more badly written reports, unless the underlying weaknesses are addressed. The undergraduate committee may consider whether the technical writing (ENGL 462) or business writing (ENGL 463) requirement is providing appropriate training for the students.

Timetable

Task: Assess the requirement of ENGL 462/463. Ask students about whether they found these courses valuable in their statistical development. Learn more about exactly what is taught in these courses. Determine whether other courses on campus might better give students the writing skills they need.

Persons responsible: Undergraduate committee, under the leadership of the undergraduate director.

Deadline: May 2018.

II. FUTURE ASSESSMENT PLAN FOR 2017 - 2018

Mission Statement

The professors, instructors, and undergraduate advisors in the Department of Statistics serve society by: (1) providing high quality education and training in statistics, (2) extending the frontiers of the discipline through research, and (3) expanding the awareness and usefulness of the discipline through public service. We strive for continual improvement in these areas. In everything we do, we conduct ourselves with openness, enthusiasm, integrity, and respect for the individual and society.

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Goal 1.

The Department expects all graduates to possess a broad basis in mathematical and applied aspects of statistical practice.

Curriculum

Undergraduate majors are required to complete MATH 141-142 (Calculus I-II), MATH 241 (Vector Calculus) or MATH 250 (Vector Analysis I), and MATH 544 (Linear Algebra) or MATH 526 (Numerical Linear Algebra) for calculus and post-calculus knowledge. Undergraduate majors are also required to complete STAT 511-513 (a three semester sequence in mathematical statistics), STAT 515-516 (Statistical Methods I-II; students may substitute STAT 509 for STAT 515), and a selection of 9 additional semester hours of coursework in advanced statistical applications (at the 500 level).

Learning Outcome 1.

Students will demonstrate the ability to perform fundamental statistical analyses and to prepare informative graphics for public presentation.

Measures and Criteria

B.S. students should successfully demonstrate mastery of the material in the two-semester sequence STAT 515-516. This sequence teaches the applications and principles of descriptive statistics, elementary probability, sampling distributions, estimation and hypothesis testing for means, variances, and proportions, simple and multiple linear regression, analysis of variance for basic designs, and analysis of covariance.

Methods

Success in meeting this learning outcome is evaluated in the spring of every year based on information collected during the previous calendar year. The primary piece of information for the evaluation is the students' demonstration of this knowledge through coursework, supplemented by the students' impressions of their knowledge as evaluated by the annual undergraduate student survey, and additional comments solicited from instructors of the statistics elective courses.

The grades of statistics majors in that year's STAT 515 and 516 courses will be examined by the Assessment Coordinator and compared to the performance or students as a whole in those classes. The undergraduate director plays the role of Assessment Coordinator.

The professor(s) of STAT 515-516 in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committee) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

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These results will be presented to the department's Undergraduate Committee during the spring of the assessment year. This committee will prepare a report on the findings, along with initial suggestions for further refinement or improvement of the program (if necessary). The committee report will be presented to the entire department as an agenda item at the annual department retreat that May, with implementation of any recommended changes beginning that summer and fall.

Learning Outcome 2.

Students will demonstrate a mastery of probability and mathematical statistics at the mathematical level of calculus and linear algebra.

Measures and Criteria

B.S. students should successfully demonstrate mastery of the material in the three-semester sequence STAT 511-513. This sequence covers probability, calculus/linear algebra-based mathematical statistics, and applications of this theory.

Methods

Success in meeting this learning outcome is evaluated every year based on information collected during the previous calendar year. The primary piece of information for the evaluation is the students' demonstration of this knowledge through coursework, supplemented by the students' impressions of their knowledge as evaluated by the annual undergraduate student survey, and additional comments solicited from instructors of the statistics elective courses.

The grades of statistics majors in that year's STAT 511, 512 and 513 courses will be examined by the Assessment Coordinator and compared to the performance or students as a whole in those classes. The undergraduate director plays the role of Assessment Coordinator.

The professor(s) of STAT 511-512-513 in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committe) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

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The Department expects all graduates to possess the necessary background for employment as a statistician in business, industry, or government.

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Learning Outcome 1.

Students will demonstrate the ability to use statistical programming languages.

Measures and Criteria

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The professor(s) of each of the applied STAT 500-level courses in each year shall be given a list of statistics majors in their course and a rubric (currently in preparation by the department's undergraduate committee, four different rubrics: 515, 540, 541, and the other applied courses) guiding them to collect examples of the students work that highlights the strengths and weaknesses of that cohort of student. They will be reminded regularly of the need to do this throughout each semester by the Assessment Coordinator, including the need to include representative samples of student coursework that demonstrates particular weaknesses.

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Learning Outcome 2.

Students will demonstrate competency in technical writing and presentation.

Measures and Criteria

B.S. students should demonstrate the ability to interpret statistical results and explain them effectively using written and/or verbal communication in STAT 515-516 and the various elective courses. Students should also demonstrate mastery of the material in ENGL 462 or ENGL 463.

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