

Group 4: Cycle 1 - Fall 2017 - Fall 2018**ASSESSMENT REPORT FOR Group 4: Cycle 1 - Fall 2017 - Fall 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.

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 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 of 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.

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?" This survey will be administered each spring through a SurveyMonkey survey and the data collected and aggregated by the SurveyMonkey software will be overseen by the Assessment Coordinator. 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

STAT 515 teachers for Fall 2018 and Spring 2019 reported that statistics majors tended to do better on average in those classes than the bulk of the class did. One teacher did report that some of them want to get through the classes doing the minimum amount of work. However, this instructor did note that there were some wonderful students who were statistics majors, and other students who displayed a strong effort.

STAT 516 teachers reported that statistics majors performed as well or better than average, with rare exceptions, in this important course in which many fundamental applied statistical methods are taught in detail.

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 23, 2019, 29 students have filled out the survey (this was a volunteer sample, so results may not be representative of the undergraduate statistics major population as a whole). Of the respondents, there were 3 freshmen, 3 sophomores, 9 juniors, 7 seniors, and 7 who had already graduated.

In assessing their own ability to "analyze data", 9 rated themselves excellent, and 19 rated themselves competent. Only 1 rated himself or herself not yet competent. So $28/29 = 97\%$ rated themselves at least competent at this.

This is similar to the $22/23 = 96\%$ who rated themselves at least competent at this in a 2017 survey.

In assessing their own ability to "use graphical displays to portray information from a statistical analysis", 8 rated themselves excellent, and 19 rated themselves competent. Only 2 rated themselves not yet competent. So $27/29 = 93\%$ rated themselves at least competent at this.

This is slightly higher than the $20/23 = 87\%$ who rated themselves at least competent at this in a 2017 survey.

Use of Results

To remedy this, the statistics department should ensure that these core applied classes have very regular homework assignments, preferably involving data analysis implemented with statistical software, to encourage students to work hard consistently.

A new survey question asked: "If a formal "concentration in data science" were offered within the statistics major (similar to our "concentration in actuarial science") that included a required minor in data science (which would likely involve taking some extra computer science courses), how likely would you be to pursue such a concentration?"

45% said Very Likely, 14% said Likely, 10% said neither likely nor unlikely, 24% said Unlikely, and 7% said Very Unlikely. Since a majority of students seem interested in such a concentration, the statistics

undergraduate committee should pursue the creation of such a concentration.

In the free-response section, student comments included the following ideas:

- * One student thinks the department should be offering courses teaching Python/SQL, and maybe offering more electives each semester in general. Another agreed that Python should be taught.
- * Several students, in fact, wanted more emphasis on programming and computer science.
- * Several students preferred more real-life applications, projects, and presentations, and less theoretical work.
- * One student wanted an emphasis on summer internships.

Ideas for addressing this include possibly developing a data science concentration in the major that would require more programming and applied courses and more computer science courses. To some degree, statistics faculty could teach more courses with a programming emphasis, if they have the expertise.

We can also work to establish relationships with entities on-campus and off-campus where students could do internships and get hands-on experience. This will become even more necessary once the Experiential Learning requirement is established at USC.

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 of 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 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.

The Assessment Coordinator will prepare a summary of student responses to the 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.

This survey will be administered each spring through a SurveyMonkey survey and the data collected and aggregated by the SurveyMonkey software will be overseen by the Assessment Coordinator.

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

Instructors for the STAT 511-512-513 sequence for Fall 2018 and Spring 2019 reported that statistics majors did roughly as well as the regular students in these courses. One of the instructors noted that the mathematical skills of the students is relatively weak, with basic skills like algebra and calculus on the decline. One suggestion is to encourage our students to retake Calculus 1 and 2 at USC even if they have AP credit, especially the weaker students. It could be that just getting AP credit is not good enough preparation for formal probability and mathematical statistics work in college. Another possibility is that students who got AP credit for calculus in high school had a relatively large gap between when they took calculus and when they started the 511-512-513 sequence.

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 23, 2019, 29 students have filled out the survey (this was a volunteer sample, so results may not be representative of the undergraduate statistics major population as a whole). Of the respondents, there were 3 freshmen, 3 sophomores, 9 juniors, 7 seniors, and 7 who had already graduated.

In assessing their own ability to "apply calculus, linear algebra, and statistical theory to solve 'real-life' problems in statistics", 7 rated themselves excellent, 19 rated themselves competent, and 3 rated themselves not yet competent. So $26/29 = 90\%$ rated themselves at least competent at this. It should be noted that 72% of the respondents had taken STAT 511, the first course of the theoretical sequence, yet. Only 38% of the respondents had finished the 511-512-513 sequence. So some students had not yet been trained in this area.

This is substantially higher than the $15/23 = 65\%$ who rated themselves at least competent at this in a 2017 survey. The percentages of students having completed STAT 511 and STAT 513 in the 2017 survey were similar to the percentages given above for the 2019 survey.

While we have improved this percentage, it is uncertain whether this is real improvement, or whether it is simply that the students' opinions of their abilities has improved. The comments of the instructors of the theoretical courses indicates that there is still room for improvement.

Use of Results

A good goal for 2019-2020 is to examine the backgrounds of the students in STAT 511 and 512. When did these students take calculus, and what were their calculus grades? A regression model could be built to predict statistics majors' STAT 511 and 512 grades based on their grades in the three prerequisite calculus classes, and how long ago their calculus classes were taken.

A previous iteration of this B.S. program assessment noted, "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 prerequisite) for STAT 511 only for those students who earned B's or better in MATH 141 and 142."

The deeper study of the relationship between calculus scores and STAT 511 success could shed light onto whether these remedies are sensible.

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 annual undergraduate student survey, and additional comments solicited from instructors of the statistics elective courses.

This survey will be administered each spring through a SurveyMonkey survey and the data collected and aggregated by the SurveyMonkey software will be overseen by the Assessment Coordinator.

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 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

The skills in statistical programming languages are judged based on performance in the required class STAT 540, and to a lesser degree, STAT 541. The instructor for STAT 540 in Fall 2018 reported that grades of statistics majors in STAT 540 were solid, and quite similar to grades of the class as a whole. Students had strengths in the basics of R and SAS programming, and their weaknesses were in more specific programming tasks. Often, poor performance on take-home assessments was attributable to starting the assignment too late. In STAT 541, performances were excellent. The statistics majors did quite well, at least as well as the class as a whole. Often performances in STAT 541 are very high because only students who are especially good at programming choose to take STAT 541.

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 23, 2019, 29 students have filled out the survey (this was a volunteer sample, so results may not be representative of the undergraduate statistics major population as a whole). Of the respondents, there were 3 freshmen, 3 sophomores, 9 juniors, 7 seniors, and 7 who had already graduated.

In assessing their own ability to "to use statistical programming languages", 9 rated themselves excellent, 11 rated themselves competent, and 9 rated themselves not yet competent. So $20/29 = 69\%$ rated themselves at least competent at this. 69% 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. Or it could be that those 20 students who have taken STAT 540 felt competent, and the ones who have not yet taken STAT 540 did not feel competent.

This is somewhat lower than the $18/22 = 82\%$ who rated themselves at least competent at this in a 2017 survey. This indicates there is room for improvement. Perhaps we could encourage earlier feelings of competence in programming by strengthening the emphasis on R and SAS programming in our earlier applied courses such as STAT 515 and 516.

Use of Results

To improve programming performance, we can perhaps give more homework assignments in STAT 540, possibly shorter assignments but at more regular intervals. STAT 540 is a large class, and having more assignments puts extra stress on the grader, but the students could certainly use as much programming practice as they can get. Having more regular assignments may also encourage students to start earlier, which is a key aspect to programming success, since there is a lot of trial and error. Another thing that could be helpful is to continue to emphasize programming throughout the other courses in the statistics major. Courses like STAT 515 and 516 already have programming in SAS and R as important components of their curricula. Other courses, such as STAT 520, 530, 535, and 587 also use programming (mostly in R) extensively. We could look to emphasize programming throughout a wider range of courses.

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 year based on information collected during the previous calendar year. 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 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.

This survey will be administered each spring through a SurveyMonkey survey and the data collected and aggregated by the SurveyMonkey software will be overseen by the Assessment Coordinator.

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Results

In terms of the writing skills of statistics majors: The STAT 530 and STAT 520 instructors assigned written projects as a major part of the course. In STAT 520, the statistics majors performed at a similar level on these assignments as did the class as a whole. In STAT 530, statistics majors performed nearly as well on these writing assignments as the class as a whole, but note that in STAT 530, a large portion of the class consists of graduate students. So the writing ability of statistics majors, and their ability to interpret results in written form, is decent, although there is always room for improvement.

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.

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In assessing their own ability to "explain statistical results", 16 rated themselves excellent, and 13 rated themselves competent. No one rated themselves not yet competent. So $29/29 = 100\%$ rated themselves at least competent at this. 48% 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.

This is the same as the $23/23 = 100\%$ who rated themselves at least competent at this in a 2017 survey.

Use of Results

Having more classes with assigned written projects is a good way to improve this aspect of the students' education. The undergraduate committee may continue to consider whether the technical writing (ENGL 462) or business writing (ENGL 463) requirement is providing appropriate training for the students.