

Introductory Statistics Course Redesign: A Collaborative Effort

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Introduction

A group of faculty at Eastern Kentucky University (EKU), a four-year regional institution, collaborated via the university's general education redesign program, which emphasizes pedagogical changes, to update an introductory statistics course with goals of greater consistency, more active learning, enhanced inclusivity and transparency, built-in professional development, and increased technology use. Prior to the redesign, instructor strategies and adherence to GAISE recommendations varied considerably. The group produced five activities, three computer projects, and a revised syllabus for use in two classes of approximately 95 students each and several small sections of approximately 30 students each in the spring of 2023. Team teaching in the large classes allowed faculty pairs to learn from each other. Faculty agreed to emphasize technology and eliminate tables.

Course Information

STA 215, Introduction to Statistical Reasoning

- 3-credit-hour introductory statistics course
- Text: *Statistics: The Art and Science of Learning from Data*, 5th Ed., Alan Agresti, Christine A. Franklin, & Bernhard Klingenberg
- 1-credit-hour corequisite course, STA 215P, for students with academic readiness needs
- Taken by students with a variety of majors, including nursing and occupational science

Collaboration

A team of faculty in the Department of Mathematics and Statistics agreed to participate in EKU's EngaGE program (<https://engage.eku.edu/>) to redesign STA 215, Introduction to Statistical Reasoning, in terms of pedagogy. One of the faculty members serves as a mentor for the program and led the group in its efforts. The EngaGE program falls under the university's Faculty Center for Teaching & Learning (FCT&L). The Assistant Provost, who serves as the director of FCT&L, provided additional guidance for the group, including helpful suggestions for making the course syllabus template more welcoming to students. The Director of the Center for STEM Excellence also served on the team and provided resources for the class activities developed by the group.

Redesign Efforts

The redesign team began its work in the summer of 2022 and completed most of it in the fall semester of 2022. The two pairs of team teachers agreed to use all of the redesign materials in their classes in the spring semester of 2023, and the materials were provided as optional tools to the small classes taught by adjunct faculty, who were not part of the redesign team. The e-Campus (100% online asynchronous) section did not use any of the materials because the university's e-Campus classes do not make substantial changes without going through an official, approved redevelopment.

Emphasis on Technology

After surveying students in STA 215 regarding access to technology and exploring the availability of technology on campus, faculty decided to eliminate table use and require students to use the TI-84. Students were asked which items they could potentially bring to class. Responses are summarized in Table 1. Samples were not random.

S22, n = 93 F22, n = 215	Laptop	Chrome-book	Tablet	iPad	Smart Phone	Graphing Calculator
Spring 2022	84 (90.32%)	7 (7.53%)	7(7.53%)	28 (30.11%)	70 (75.27%)	69 (74.19%)
Fall 2022	192 (89.30%)	24 (11.16%)	10 (4.65%)	41 (19.07%)	190 (88.37%)	160 (74.42%)

Table 1: Technology Survey Results

Activities

The redesign team created or adapted the following activities for in-class use:

- A regression activity that uses spring toys, baskets, and candy (or beads)
- A probability activity based on the game show problem
- A sampling distribution activity based on the "Advanced ESP Test" by Psychic Science found at <https://psychicscience.org/esp3>
- A sampling distribution and confidence interval activity based on the Gettysburg Address activity (various versions can be found online)
- An adaptation of the "Should Flint switch to bottled water?" activity from Stats Medic found at <https://www.statsmedic.com/intro-chapter8-day8>

Computer Projects

The redesign team created three Minitab projects:

- A descriptive statistics project based on the brain waves data set found at <https://dasl.datadescription.com/datafile/brain-waves/>
- A correlation and regression project based on airport data from 1990
- A confidence interval project based on the article "Young People Experiencing 'Widespread' Psychological Distress Over Government Handling of Looming Climate Crisis, Researchers Say" found at <https://abcnews.go.com/International/young-people-experiencing-widespread-psychological-distress-government-handling/story?id=79990330>; an alternative version based on a different article was also developed

Transparency was incorporated into the projects by including the purpose, task, and score sheet for each. The confidence interval project asked students to critically read the news article and skim the original research article.

Syllabus Template Updates

The course coordinator made the following changes to the syllabus:

- Removed harsh lines from table format
- Updated headers to encourage students to read further
- Added visual identifiers from The Noun Project
- Replaced "Warning" label with "Check Your DegreeWorks"

Assessment Results

Variations of two problems (confidence interval about a mean, hypothesis test about a proportion) from Introduction to Statistical Reasoning exams in Spring 2019 (final exam), Spring 2021 (third exam), and Spring 2023 (final exam) were assessed using EKU's General Education Element 2 rubric (revised and integrated, found at https://gened.eku.edu/sites/gened.eku.edu/files/files/GE_QEP_Rubric_2.pdf). All exams were assessed in Spring 2019, and stratified random samples of size 40 each were assessed in Spring 2021 and Spring 2023. The problems selected in Spring 2023 were scored by a statistics faculty member who did not teach STA 215 that semester. Results are summarized in Table 2.

S19, n = 560 S21, n = 40 S23, n = 40		4 Accomplished Exceeds course expectations	3 Competent Meets course expectations	2 Developing Incomplete in meeting course expectations	1 Beginning Inadequate in meeting course expectations
Criterion					
Comprehension	S19 S21 S23	N/A N/A N/A	335 (59.82%) 20 (50.00%) 17 (42.50%)	133 (23.75%) 11 (27.50%) 10 (25.00%)	92 (16.43%) 9 (22.50%) 13 (32.50%)
Terminology & Notation	S19 S21 S23	142 (25.36%) 12 (30.00%) 4 (10.00%)	118 (21.07%) 4 (10.00%) 6 (15.00%)	116 (20.71%) 7 (17.50%) 10 (25.00%)	184 (32.86%) 17 (42.50%) 20 (50.00%)
Methods & Analysis	S19 S21 S23	62 (11.07%) 4 (10.00%) 4 (10.00%)	157 (28.04%) 7 (17.50%) 6 (15.00%)	196 (35.00%) 17 (42.5%) 12 (30.00%)	145 (25.89%) 12 (30.00%) 18 (45.00%)
Mathematical/ Logical Operations	S19 S21 S23	131 (23.39%) 9 (22.50%) 5 (12.50%)	54 (9.64%) 13 (32.50%) 2 (5.00%)	151 (26.96%) 7 (17.50%) 15 (37.50%)	224 (40.00%) 11 (27.50%) 18 (45.00%)
Interpretation/ Evaluation	S19 S21 S23	134 (23.93%) 16 (40.00%) 8 (20.00%)	190 (33.93%) 13 (32.50%) 18 (45.00%)	129 (23.04%) 3 (7.50%) 0 (0.00%)	107 (19.11%) 8 (20.00%) 14 (35.00%)
Integration/ Synthesis	S19 S21 S23	242 (43.21%) 22 (55.00%) 14 (35.00%)	117 (20.89%) 5 (12.50%) 11 (27.50%)	123 (21.96%) 8 (20.00%) 7 (17.50%)	78 (13.93%) 5 (12.50%) 8 (20.00%)

Table 2: General Education Assessment Results

The redesign team developed 10 multiple choice questions that they thought reflected the concepts they identified as bases for the activities and computer projects they developed. Data from all Spring 2023 final exams are summarized in Table 3 (except for four missing papers).

Question	Number (Percent) Correct All Sections n = 283	Number (Percent) Correct e-Campus Excluded n = 215
Histogram shape	215 (75.97%)	167 (77.67%)
Measure of center	92 (32.51%)	73 (33.95%)
Regression equation	251 (88.69%)	193 (89.77%)
Slope interpretation	232 (81.98%)	175 (81.40%)
Legitimacy of discrete probability distribution	221 (78.09%)	169 (78.60%)
Legitimacy of discrete probability distribution	218 (77.03%)	169 (78.6%)
Sampling distribution	41 (14.49%)	25 (11.63%)
Central Limit Theorem	65 (22.97%)	47 (21.86%)
Effect of confidence level on confidence interval width	174 (61.48%)	131 (60.93%)
Interpretation of confidence interval for difference in proportions	110 (38.87%)	72 (33.49%)

Table 3: Common Multiple Choice Question Results

Assessment Comments

General Education assessment scores generally decreased in Spring 2023. Of course, it is impossible to measure the impact of the pandemic. It is interesting to note that the e-Campus section had lower scores on the open-ended questions (not shown here) but higher scores on half of the multiple choice questions than the on-campus sections.

Instructor Feedback

Five of the six on-campus instructors completed a brief survey. All of them reported using all of the activities and computer projects developed by the redesign group. Faculty generally embraced the use of calculators instead of tables. Several faculty indicated that pacing was an issue and that it was difficult to find time to complete all of the activities.

Student Feedback

In response to the question "What aspects of this course helped you learn?" on the course evaluation form, 16 of the 89 students from the large lectures who responded said something about the in-class activities, and 4 students mentioned the computer projects or software. The course evaluation survey did not specifically ask students about the activities or computer projects.

Recommendations

Some recommendations for ongoing improvement of STA 215 (Introduction to Statistical Reasoning) include the following:

- Continue to make activities and computer projects available to STA 215 instructors
- Provide faculty with professional development opportunities that promote active learning and student engagement
- Update documents to make them more accessible
- Give faculty more resources for teaching students about sampling distributions
- Consider moving from calculators to computers when resources allow

Selected References

Jacobo, J. (2021, September 14). Young people experiencing "widespread" psychological distress over government handling of looming climate crisis, researchers say. *ABC News*. <https://abcnews.go.com/International/young-people-experiencing-widespread-psychological-distress-government-handling/story?id=79990330>

Significance Tests for a Mean. (2023). Stats Medic. <https://www.statsmedic.com/intro-chapter8-day8>

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