Visualization: An Interdisciplinary Honors Course in Statistics, Art, Psychology, and History

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Abstract
Two versions of a team-taught honors course that combines statistics, art, psychology, and history will be described. Visualization provides the basis for discussions about statistical concepts, artistic perspective, visual perception, and historical context. Data visualization is part art, part science; graphic design lies at the confluence of art and statistics. This course examines principles of design and best practices in graph construction in the context of art, visual perception, and history. Using books by Nathan Yau and Edward Tufte, as well as various internet sites, the instructors guide students through discussions and activities that introduce and reinforce sound principles of visual presentation of information. The contributions of professors from four different fields will be discussed, and the modifications to the course made via an instructor change will be described. Assessment results and examples of student projects will be presented.

Key Words: visualization, interdisciplinary, honors, course

1. Introduction

Visualization: Statistics, Art, & History was a new team-taught honors course at Eastern Kentucky University (EKU) first offered in the spring semester of 2019. An updated version of the course, Visualization: Statistics & Perception, was offered in the spring semester of 2020. Visualization provides the basis for discussions about statistical concepts, artistic perspective, visual perception, and historical context. This course examines principles of design and best practices in graph construction in the context of art, visual perception, and history. Using books by Nathan Yau and Edward Tufte, as well as various internet sites, the instructors guide students through discussions and activities that introduce and reinforce sound principles of visual presentation of information.

Initially designed by professors of statistics and art, and first team-taught by professors of statistics and history, an honors course in visualization was revised in conjunction with an instructor change in the second offering of the course in 2020. A psychology professor injects expertise in visual memory and perception into a course that combines statistics, art, and history. Course requirements include daily assignments, in-class activities, computer projects, midterm and final exams, a research project, a creative project, and a presentation. The course transitioned to virtual learning after spring break. The class held synchronous virtual meetings, and attendance was quite good.

2. Course Details

Required texts for the course include *Data Points: Visualization That Means Something* by Nathan Yau (2013) and *Beautiful Evidence* by Edward Tufte (2006). Excerpts from *The Visual Display of Quantitative Information* (Tufte 2001) and other supplemental readings were utilized in both versions of the course. The honors course has a writing-intensive designation, and it fulfills a general education requirement. Students sign up for the interdisciplinary course so that it fills one of three major areas included in the course within general education structure. The prerequisite is an honors rhetoric course. The quantitative backgrounds of students vary widely; some students have already completed at least one statistics course, while some have limited quantitative skills.

3. Updates to Course in Spring 2020

While the professor of statistics remained a constant, the professor of history was replaced by a professor of psychology in 2020. Based on the expertise of the new instructor, a class session was devoted to an introduction to visual perception. There were some adjustments to required readings, primarily due to the instructor change. A library session was inserted into the schedule; a librarian led the students through a session on research and database searches. The instructors incorporated TILT (Transparency In Learning and Teaching) into some assignments and added a metacognitive strategy, a midterm exam wrapper. They provided the students with more infographic resources and discussed the project requirements earlier in the semester. The Spring 2020 semester included more activities, including a scavenger hunt for chartjunk in the library, a correlation guessing game, and bingo with terminology related to statistics and visual perception. Several changes related to the COVID-19 response after spring break were made: the class transitioned to synchronous virtual meetings, the instructors made more extensive use of the learning management system for the collection of assignments, and the final exam was unproctored.

4. Examples of Student Work

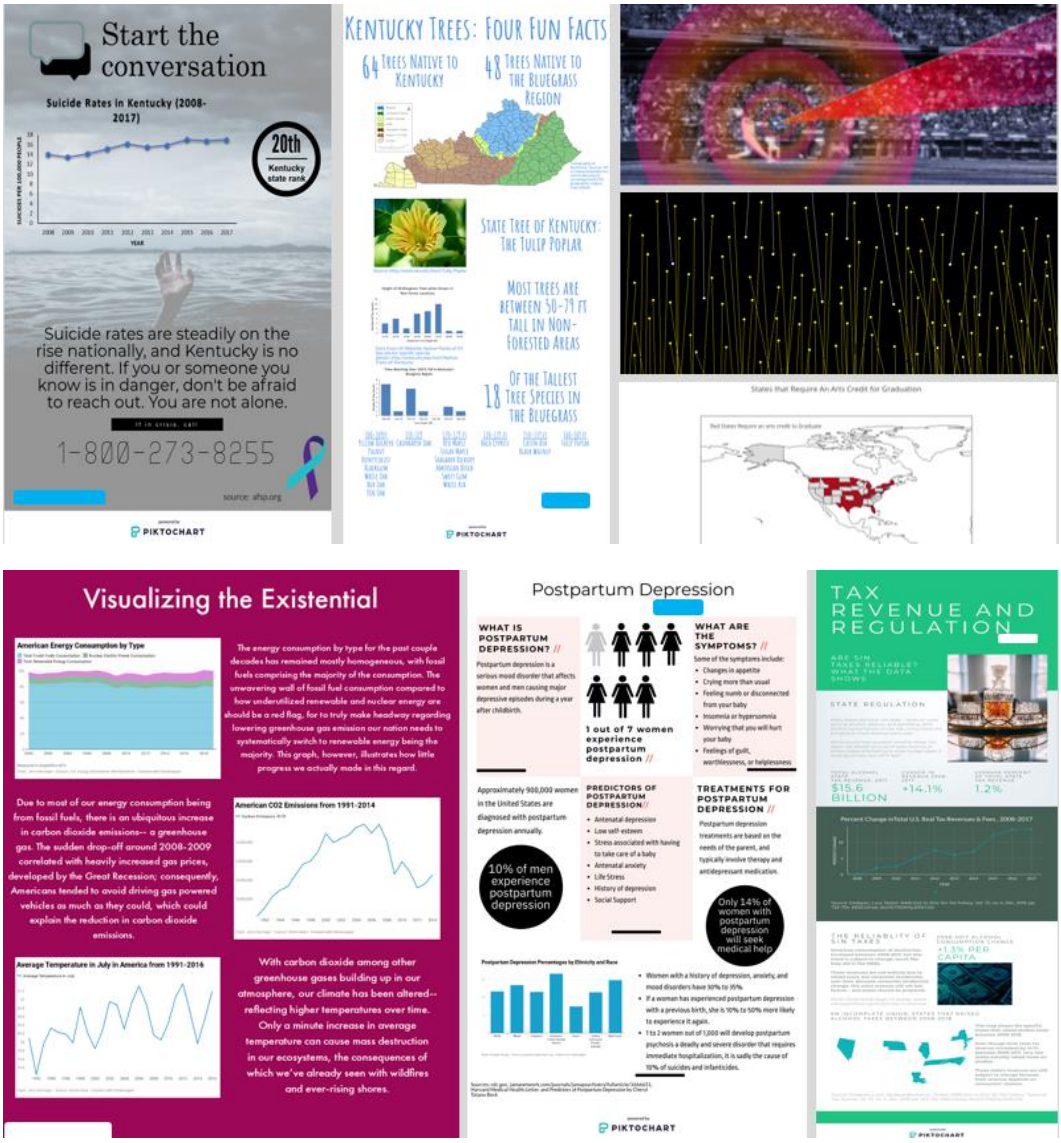

Figure 1: Collage of Examples of Student Work

5. Assessment Data

Two problems involving graphics from each of the midterm exam and final exam from the Spring 2019 and Spring 2020 Visualization courses were assessed using EKU's General Education Integrated Element 2 rubric, found at https://gened.eku.edu/general-education-assessment. Results are summarized in Tables 1 and 2.

Table 1: Assessment Data, Visualization Course, Spring 2019, $n = 15$

Criterion		**4 Accomplished** ***Exceeds course expectations***	**3 Competent** ***Meets course expectations***	**2 Developing** ***Incomplete in meeting course expectations***	**1 Beginning** ***Inadequate in meeting course expectations***
Terminology and Notation	**Midterm**	1 (6.7%)	13 (86.7%)	1 (6.7%)	0 (0.0%)
	Final	2(13.3%)	7 (46.7%)	6 (40.0%)	0 (0.0%)
Interpretation/ Evaluation	**Midterm**	4 (26.7%)	10 (66.7%)	1 (6.7%)	0 (0.0%)
	Final	0 (0.0%)	13 (86.7%)	2 (13.3%)	0 (0.0%)

Table 2: Assessment Data, Visualization Course, Spring 2020, $n = 20$
(one midterm makeup not scored; one student did not take final)

Criterion		**4 Accomplished** ***Exceeds course expectations***	**3 Competent** ***Meets course expectations***	**2 Developing** ***Incomplete in meeting course expectations***	**1 Beginning** ***Inadequate in meeting course expectations***
Terminology and Notation	**Midterm**	0 (0.0%)	9 (45.0%)	11 (55.0%)	0 (0.0%)
	Final	2 (10.0%)	4 (20.0%)	5 (25.0%)	9 (45.0%)
Interpretation/ Evaluation	**Midterm**	3 (15.0%)	14 (70.0%)	3 (15.0%)	0 (0.0%)
	Final	2 (10.0%)	11 (55.0%)	7 (35.0%)	0 (0.0%)

6. Student Feedback

Students in the Spring 2019 Visualization class provided midterm feedback given to the professors. They generally found the workload to be doable, they thought the class discussions were interesting, they suggested more smaller computer projects and activities, they liked opportunities to be creative, and they enjoyed guest lectures given by the art professor. Students in the Spring 2019 Visualization class also provided end-of-term feedback via online eXplorance Blue evaluations. Comments indicate a positive reaction to computer projects and daily assignments; one student suggested including fewer words on slides. The Spring 2020 midterm feedback papers were left with one instructor's graduate assistant prior to campus closure. Students in the Spring 2020 Visualization class provided end-of-term feedback via online eXplorance Blue evaluations. The students found readings, activities, and computer projects to be helpful. One student found the material repetitive; another suggested a slower pace.

7. Instructor Observations

The instructors of the Spring 2019 Visualization class made the following observations: some students produced higher quality visualizations on computer projects and daily assignments than on final projects, and a few students could have used more guidance in the use of technology. The instructors of the Spring 2020 Visualization class noted the following: several students struggled with visual perception terminology on the midterm exam; students were given more resources and advice related to infographics in Spring 2020, and the resulting infographics were better than those produced in Spring 2019; and students seemed to enjoy the activities, particularly the scavenger hunt in the library and the games.

8. Suggestions for Future Updates

The instructors have several suggestions for future iterations of the course. Providing students with more guidance with regard to how to study for exams and discouraging mere memorization of definitions may lead to greater student success on exams. Students seem to enjoy using technology in the course, so the addition of more computer usage has the potential to increase student satisfaction and technological skills. The instructors would also like include more activities to reinforce understanding of terminology since students seem to struggle with vocabulary. They are also considering the utilization of more active learning strategies, including games. The teaching pair also plans to encourage students to explore different formats for creative projects besides infographics and websites.

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