Incorporating Visual Literacy Standards in an Introductory Statistics Course

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Abstract

Twenty-first-century learners use the Internet to find answers to questions. Popular approaches to finding answers include search engines (e.g., Google) and applications (e.g., Wikipedia). Antiquated approaches to solving mathematical and statistical problems are replaced with sophisticated applications (e.g., Excel). Anyone with Internet access can use YouTube to gain knowledge about nearly every subject. In this context, how might we, as imparters of knowledge, engage students in learning statistics?

The focus of this discussion revolved around a project conducted in an introductory college course on business statistics. Students used statistics to analyze e-voting data and learned how to visually represent their analysis. Students were introduced to infographic software and visual literacy competencies. Working in small groups, students used infographic software to develop visual analyses. The instructor and librarian instructor established a rubric for students as a framework for their visual representation. Students developed and demonstrated knowledge in all seven skill areas defined in the Visual Literacy Competency Standards for Higher Education.

Key Words: infographics, visual literacy, introductory statistics, visualization, data analysis

1. Introduction

Sixty undergraduate students enrolled in a required introductory, business statistics course downloaded infographic software and learned how to create a visual statistical analysis using engaging data. The semester long statistics course had three goals in addition to the stated course goals: to embed an electronic voting (e-voting) project to allow students to vote on e-voting machines and use statistics to analyze the e-voting data; to visually represent their analysis; and to incorporate visual literacy standards in a visual representation.

Students working in small groups of size three to five were required to use infographic software to develop a visual analysis. Additionally, students were told they would present their analysis to the class and use a rubric developed by the instructor and librarian instructor to vote on each other's presentation to determine the three best presentations. Creators of the three winning infographics presented their analysis to the Secretary of State via a webcast.

2. Literature Review

The term "visual literacy' was first used by the writer John Debes in 1968 (Bamford, 2003). According to Hattwig, Bussert, Medaille and Burgess (2013), visual literacy is a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images. However, Kienzler (1997) warned that creating visuals takes skill to ensure an accurate image. The Association of College and Research Libraries (ACRL) formalized visual literacy skills students can use to understand and analyze the contextual, cultural, ethical, aesthetic, intellectual, and technical components involved in the production and use of visual materials. According to Harris (2010), librarians and teachers notice an increase in student usage of visuals and see the need for student to learn skills to analyze visual images.

In addition to increased use of visualization in education, visualization in businesses are increasing. Initially, visualizations were primarily seen in newspapers (Toth, 2014). However, many company websites and marketing brochures contain visualizations. According to Toth, visual images in resumes will soon become the status quo. Consequently, students must learn to assess visual images that stand alone and correctly portray trustworthy information (Toth). Brumberger (2011) surveyed students who admitted to limited skills using technology to produce visual images.

As Brumberber (2011) stated, although 21st century learners are skilled in surfing the Internet, they must learn how to effectively evaluate and create visual images. Images are becoming increasingly more sophisticated; consider the depth of information displayed in a thumbnail picture (Snavely, Arp, &Woodard, 2005). It is in this context coupled with the challenge of engaging students in an introductory statistics course that this project was offered.

3. Methodology

The aim of this project was to enhance student interest in learning statistics by using visual literacy skills. Visual literacy skills focus on 21st century learners and assume students have a basic familiarity with electronic devices and applications (Hattwig et al., 2013). Students were exposed to statistical course material, technology for visualization, and visualization skills.

3.1 Setting and participants

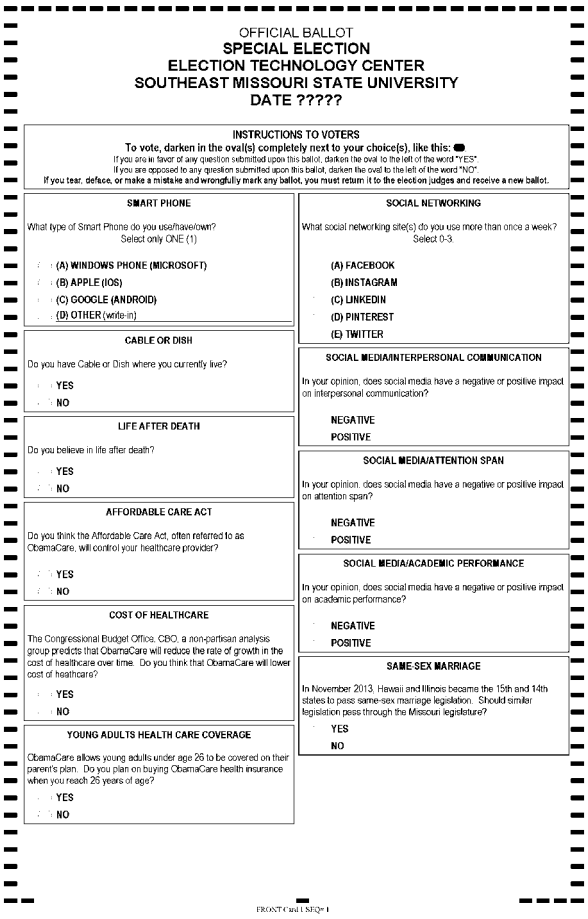
The project took place in the classroom and the computer lab at Southeast Missouri State University. The school is located 100 miles south of St. Louis and the majority student population come from the metropolitan areas around St. Louis and the rural counties in Southern Missouri and Illinois.

The participants in this project were sophomore and junior level students fulfilling a core course requirement. The project was led by the instructor with input from the librarian instructor. Additionally, the Cape Girardeau County Clerk, an election official responsible for countywide elections, participated in the project and instructed students on election process codified in Missouri.

3.2 Project Design

In addition to students demonstrating their knowledge in statistics by analyzing e-voting data with a visual representation, students created their visual representation based on the seven literacy skills standards. Students were introduced to statistical terms and concepts (variables, central tendencies, normal distributions) then learned how to use Easel.ly, an infographic application. This application was selected because it is free and user friendly. Additionally, students were exposed to information related to voting.

Adkins Printing, Inc. loaned the school three touchscreen voting machines with paper attachments (Accuvote TSx). Adkins programmed the machines with questions developed by two faculty members with input from the Student Body President. The questions were meant to be interesting and relevant to students. Figure 2 lists the mildly controversial questions.



OFFICIAL BALLOT
SPECIAL ELECTION
ELECTION TECHNOLOGY CENTER
SOUTHEAST MISSOURI STATE UNIVERSITY
DATE ?????

INSTRUCTIONS TO VOTERS
To vote, darken in the oval(s) completely next to your choice(s), like this: ●
If you are in favor of any question submitted upon this ballot, darken the oval to the left of the word "YES".
If you are opposed to any question submitted upon this ballot, darken the oval to the left of the word "NO".
If you tear, deface, or make a mistake and wrongfully mark any ballot, you must return it to the election judges and receive a new ballot.

SMART PHONE
What type of Smart Phone do you use/have/own?
Select only ONE (1)
- (A) WINDOWS PHONE (MICROSOFT)
- (B) APPLE (IOS)
- (C) GOOGLE (ANDROID)
- (D) OTHER (write-in)

CABLE OR DISH
Do you have Cable or Dish where you currently live?
- YES
- NO

LIFE AFTER DEATH
Do you believe in life after death?
- YES
- NO

AFFORDABLE CARE ACT
Do you think the Affordable Care Act, often referred to as ObamaCare, will control your healthcare provider?
- YES
- NO

COST OF HEALTHCARE
The Congressional Budget Office, CBO, a non-partisan analysis group predicts that ObamaCare will reduce the rate of growth in the cost of healthcare over time. Do you think that ObamaCare will lower cost of healthcare?
- YES
- NO

YOUNG ADULTS HEALTH CARE COVERAGE
ObamaCare allows young adults under age 26 to be covered on their parent's plan. Do you plan on buying ObamaCare health insurance when you reach 26 years of age?
- YES
- NO

SOCIAL NETWORKING
What social networking site(s) do you use more than once a week?
Select 0-3
- (A) FACEBOOK
- (B) INSTAGRAM
- (C) LINKEDIN
- (D) PINTEREST
- (E) TWITTER

SOCIAL MEDIA/INTERPERSONAL COMMUNICATION
In your opinion, does social media have a negative or positive impact on interpersonal communication?
- NEGATIVE
- POSITIVE

SOCIAL MEDIA/ATTENTION SPAN
In your opinion, does social media have a negative or positive impact on attention span?
- NEGATIVE
- POSITIVE

SOCIAL MEDIA/ACADEMIC PERFORMANCE
In your opinion, does social media have a negative or positive impact on academic performance?
- NEGATIVE
- POSITIVE

SAME-SEX MARRIAGE
In November 2013, Hawaii and Illinois became the 15th and 14th states to pass same-sex marriage legislation. Should similar legislation pass through the Missouri legislature?
- YES
- NO

FRONT Card 1 SEQ# 1

Figure 1: E-Voting Questions

Students were given an assignment to vote on the machines and received points for completing the assignment. The voting machines were collocated with the Student Government offices that had a receptionist. The receptionist was in charge of the token students needed to access the ballot. The receptionist verified students from their university issued identification card and issued them a token. By scanning the card, the receptionist recorded that the student voted and was ineligible to vote again. (Similar to

current voting law. The touchscreen allowed the voter to make changes and corrections to the ballot before submitting it.) After the student voted and returned the token to the receptionist, the receptionist gave the student an "I Voted" sticker. The student submitted the sticker to receive points for the assignment.

Furthermore, students could invite their friends (other students) to vote. Voting was available for all students. Students in the statistics class could submit their friend's sticker for extra credit. The student published newspaper printed an article about the project and in this way anyone reading the newspaper was aware of the project. Of course, sample size and population were topics in the course. Thusly, students experienced the concept of sample size as they were informed how maximum participation provides for a good analysis. After student voting ended, the process to analyze the data began.

To help prepare the students to analyze the voting data, they read and discussed three scholarly articles on methods to statistically analyze election results. Additionally, students attended two lectures on election administration: one from the current Cape Girardeau County Clerk; and one from a former Missouri Secretary of State (SoS). The County Clerk gave an overview of the voting process in the state of Missouri and the process used to audit votes in Cape Girardeau County. In the state of Missouri, the SoS is responsible for elections. The former SoS spoke about her experiences and talked about a very close election that she lost. When she informed the students that the machines are very accurate and she did not ask for the recount entitled to her by Missouri State Election Laws. Our class project applied statistical sampling to validate the accuracy of elections.

3.2.1 Seven Skill Areas

To inform students about skill areas defined in the Visual Literacy Competency Standards for Higher Education, the librarian instructor attended two class sessions. In the first class session, she introduced students to the infographic application and explained that data visualizations should tell a story about the data being presented. In the second class session, she introduced students to the seven literacy standards and the rubric which the students used as a framework for their visualization.

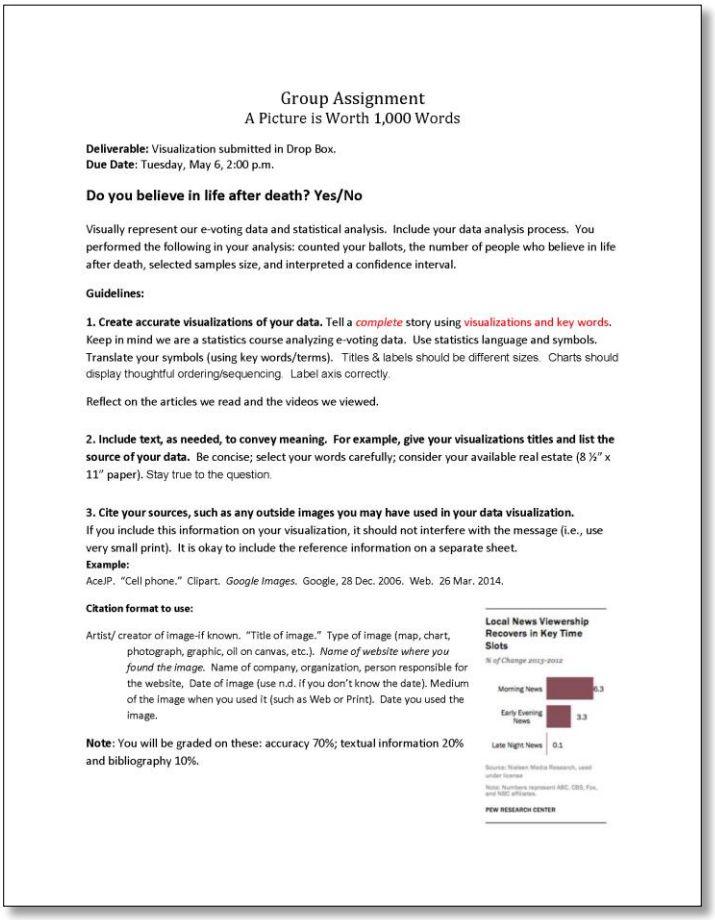
Students were exposed to three versions of the rubric. The first version was very detailed and offered lots of guidance. Each version offered less guidance than its predecessor to allow students increased opportunity to create their visualization. Figure 2 is the final version of the rubric.

Standard One addresses students showing preliminary knowledge about needing an image for academic projects. Students must think about how to incorporate images. Students were introduced to infographics as a vehicle to construct a visual story.

According to **Standard Two**, the visually literate student can find and access images. Students learned skills needed to find images for academic projects. Skills such as where to locate appropriate images, how to search for and find images, and image manipulation skills, such as knowing how to resize images, would be necessary in order to use images in their project.

Standard Three addresses students who interpret and analyze images. Students must question how meaning can be created and communicated through visual material. In place of lengthy text, images that have shared cultural meaning can convey a significant amount of information; thus images students choose must be well thought out and unambiguous.

Standard Four focuses on the student's ability to evaluate images and image sources. Students must learn to critically evaluate images and image sources using a process similar to the evaluation of written information. Thus as both creators and evaluators, students have the opportunity to practice interpretation and evaluation skills.



Group Assignment
A Picture is Worth 1,000 Words

Deliverable: Visualization submitted in Drop Box.
Due Date: Tuesday, May 6, 2:00 p.m.

Do you believe in life after death? Yes/No

Visually represent our e-voting data and statistical analysis. Include your data analysis process. You performed the following in your analysis: counted your ballots, the number of people who believe in life after death, selected samples size, and interpreted a confidence interval.

Guidelines:

1. Create accurate visualizations of your data. Tell a *complete* story using visualizations and key words. Keep in mind we are a statistics course analyzing e-voting data. Use statistics language and symbols. Translate your symbols (using key words/terms). Titles & labels should be different sizes. Charts should display thoughtful ordering/sequencing. Label axis correctly.

Reflect on the articles we read and the videos we viewed.

2. Include text, as needed, to convey meaning. For example, give your visualizations titles and list the source of your data. Be concise; select your words carefully; consider your available real estate (8 ½" x 11" paper). Stay true to the question.

3. Cite your sources, such as any outside images you may have used in your data visualization. If you include this information on your visualization, it should not interfere with the message (i.e., use very small print). It is okay to include the reference information on a separate sheet.
Example:
AceJP. "Cell phone." Clipart. *Google Images.* Google, 28 Dec. 2006. Web. 26 Mar. 2014.

Citation format to use:

Artist/ creator of image-if known. "Title of image." Type of image (map, chart, photograph, graphic, oil on canvas, etc.). *Name of website where you found the image.* Name of company, organization, person responsible for the website, Date of image (use n.d. if you don't know the date). Medium of the image when you used it (such as Web or Print). Date you used the image.

Note: You will be graded on these: accuracy 70%; textual information 20% and bibliography 10%.

Figure 2: Rubric

According to **Standard Five**, the visually literate student can use images effectively. Students approach the use of images (eg. visual materials) in a deliberate way to differentiate uses of visual materials and assess which images afford the most impact. As students create their infographics, they need to choose images wisely. Infographics are not large documents; space is limited and students need to be both efficient and effective in their image selection and in the placement of those images. In this project, student infographics were restricted to a standard size sheet of paper (8½ x11).

Standard Six defines a visually literate student as one who creates meaningful visual materials. Students produce visual materials and use a variety of sources to tell a statistical story through the creation of infographics. In creating these, students acquire skill in selecting and using images, accurately displaying data and information, using images to convey concepts, and using visual materials to tell a meaningful, compelling, and true story.

Lastly, **Standard Seven,** addresses the ethical use of creating and using visual materials with accurate citing. Accuracy was a vital part of the students' e-voting visual projects. As part of that, students were required to correctly cite any images they used, using Modern Language Association (MLA) Style.

4. Findings and Discussion

Students experienced a learning curve for the application and course material. The course material included guidelines for visualizing data. However, when the visualization was coupled with the application and literacy skills, their learning curve steepened. Feedback allowed students to engage in problem solving, visual creativity, and experimentation as they reworked data accuracy, story accuracy, images, and the overall visual impact of their project. Although aesthetics was not a required element of this project, as students became more purposeful in the overall layout of their infographics, elements of aesthetic design seemed to emerge as well.

The project compelled students to consider how to visually represent their data and tell a story about that data. They used basic skills such as identifying potential images, and considered ways images, such as simple data, like charts and graphs, could be used to communicate the data. Students began to understand that images were capable of communicating complex information. Students explored a variety of image sources on their own in order to find appropriate images. As they did this they began to encounter image-related skills necessary for incorporating images into their project.

Additionally, students learned skills of interpretation and analysis in order to use images to create infographics that are culturally situated so the visuals can be easily understood. Students practiced evaluation skills as creators of infographics. In creating and incorporating the components of their infographics, students were learning to stay true to the data, use accurate accompanying text, and tell a true story based on the actual e-voting statistical data. Students also practiced evaluation skills as consumers and evaluators of each other's presentations as they used a rubric to rate each other's work and voted to determine which would go on and be presented to the Secretary of State.

In Figure 3 we see two examples of student's first effort to visualize e-voting data. Students were tasked to use the application (Easil.ly) and create a data visualization representing the results for the question about life and death. In Figure 3 (left), we see unnecessary art. The visual representation (80% Yes and 20% No) is correct in the circular representation, but incorrect on the linear representation. The bottom half of the visualization adds very little but indicates the data source.

In Figure 3 (right), we see the actual numbers and question title behind a fuzzy layer. During the creation of that visualization, the application froze. The student submitted a screen shot to earn credit for the assignment. The application is free and occasionally students faced unexpected problems. To maintain their interest in the project and to keep their interest, students were not penalized for technical problems.

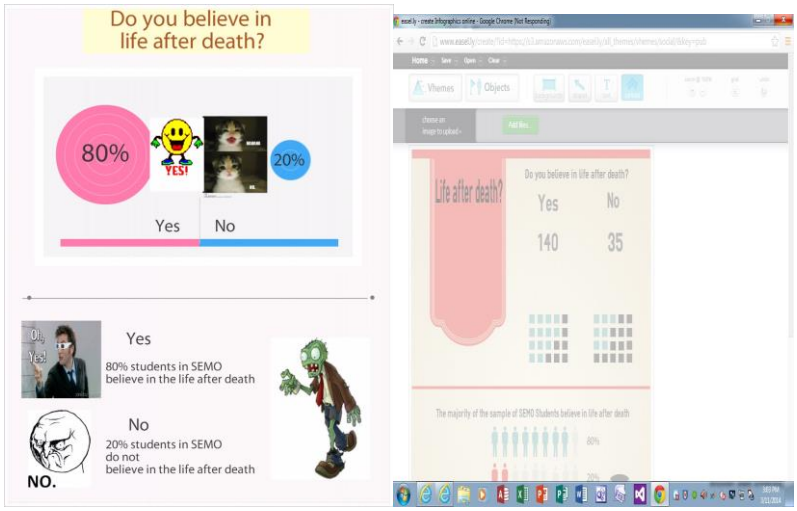


Figure 3: E-Voting Question: Life after Death

After two additional lab sessions and feedback from the first data visualization, students were tasked with creating a data visualization representing the results for the cell phone question (Figure 4). In this second data visualization, students used more graphics and less text to explain their results. With each infographic draft, students practiced image citing using examples created by the library instructor. Figure 4 students includes credit for the borrowed artwork incorporated in the visualization. The building in the background (Figure 4, left) is the school icon and the circles for 63.6% and 30% look appropriate in size and the 3.5% is smaller. However, the 2.9% circle is incorrect (perhaps students ran out of time at this session). Figure 4 (right), is a traditional representation of the data. Students added topic related art to enhance the visualization.

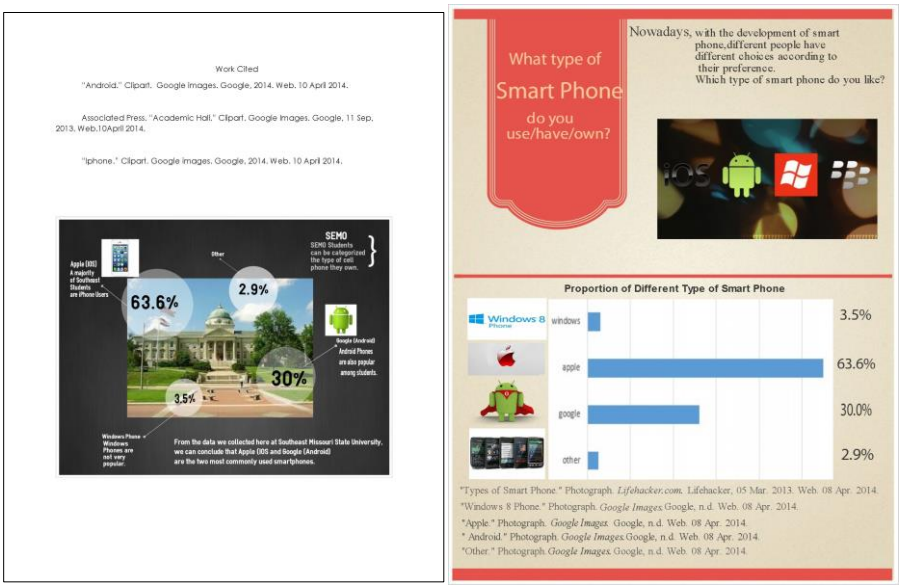


Figure 4: E-Voting Question: Cell Phone

After two additional lab sessions, students analyzed the entire set of e-voting data. At this point in the course, students learned about statistical sampling and used sampling

techniques to analyze the data. Students selected a question to analyze and were provided a rubric as a guide for the data visualization (Figure 2). Additionally, the rubric served as the criteria to select the top three data visualizations. Students used clickers to cast their vote on each other's data visualization. Those with the highest score were presented to the Missouri SoS via webcast. Figure 5 shows two of the three winning visualizations.

It was easy to observe that students enjoyed creating the one on the right. In telling their visual story, those students had to find images that could represent complex concepts in order to advance their story. They included the playing cards to express the idea of randomness. Close examination of the visualization yields several examples of the statistical course topics (i.e., randomness, sampling, population proportion). Similarly, the left visualization, includes course topics, but include traditional graphics (i.e., pie chart and arrows). However, both visualizations are detailed stories of data analyzed on a single sheet of standard paper.

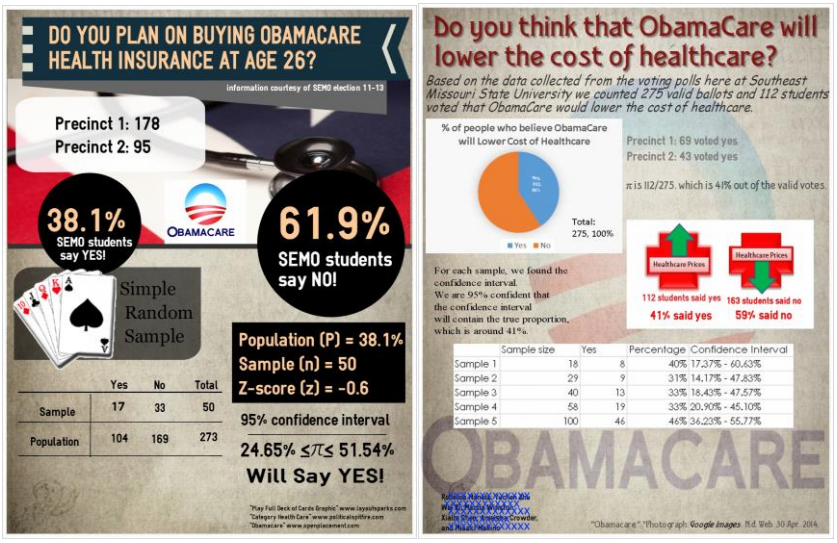


Figure 5: Winning Visualizations

It is worth mentioning, that as the project developed, class attendance did not decrease. Students attending class looked forward to working on their project and winning the competition to present their analysis to the SoS.

5. Conclusion

Twenty-first century learners in this introductory statistics class ended up enjoying their statistics class. In addition to learning course content, they learned how to use a new application to create an infographic to visually represent their data and analysis and they learned visual literacy skills to evaluate images. As the semester progressed, students' infographics became more accurate, interesting, and showed more sophistication in technical skills but also in the deliberateness of telling their story. As both creators of their own infographics and evaluators of each other's, students learned relevant skills necessary create and consume visual products in other courses or in their personal lives.

References

Bamford, A. 2003. The visual literacy white paper. Uxbridge, England: Adobe Systems, http://wwwimages.adobe.com/www.adobe.com/content/dam/Adobe/en/education/pdfs/visual-literacy-wp.pdf

Brumberger, E. 2011. Visual literacy and the digital native: An examination of the millennial learner. Journal Of Visual Literacy, 30(1), pp. 19-47.

Harris, B. R. 2010. Blurring borders, visualizing connections. Reference Services Review, 38(4), pp. 523-535. doi:http://dx.doi.org/10.1108/00907321011090700

Hattwig, D., K. Bussert, A. Medaille, and J. Burgess. 2013. Visual literacy standards in higher education: New opportunities for libraries and student learning. Portal: Libraries and the Academy, 13(1), pp. 61-89. https://muse.jhu.edu/article/498858

Kienzler, D. S. 1997. Visual ethics. Journal Of Business Communication 34(2), pp. 171-187.

Snavely, L., L. Arp, and B. S. Woodard. 2005. Visual images and information literacy. Reference & User Services Quarterly, 45(1), pp. 27-32.

Toth, C. 2014. Revisiting a genre: Teaching infographics in business and professional communication courses. Business Communication Quarterly, 76(4), pp. 446-457.