Visual Communication Learning through Peer Design Critiques: Engineering Communication Across Divisions

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Engineering communication by necessity concerns visual communication. As educators, we hope to instill students with a sense that good visual communication must be thoughtfully designed to help readers make meaning of data. Such visual design for readers requires our students to become metacognitive of their own experience as consumers of visual communication. Yet often engineering students are not prompted to think about or design visual data communication until they must present their own data, typically as part of a senior capstone project. Our students' lack of experience leaves them without a solid foundation for critical thought about figures, and thus with scant preparation to learn from the experience of creating and refining them. If capstones are to be an opportunity to learn about visual communication rather than simply perform it, students are in need of a swift means to gain perspective on user interactions with figures, starting with their own.

Highly subjective fields such as the fine arts and graphic design have long had an answer to this need to learn within open-ended yet user-centric visual modes of communication: the group critique workshop, or simply, the "critique". We adapted the concept of the critique to a workshop within a bioengineering capstone course in order to help students to sharpen their awareness of reader experience of figure design, and empower them to improve their own visual communication within their capstone reports.

Visual design pedagogy for engineering students

In order to create good visual designs, students in the arts receive an explicitly constructivist education—they create, refine, and build their own often understanding of design and technique as they practice. To guide students toward creating "good" designs (where all might agree that "good" is a socially/culturally-negotiated quality[1]), educators guide students toward sharpening and informing their own design intelligence, while keeping them in touch with socially-negotiated assessments of their work.

Two particular habits of design intelligence that instructors seek to foster are observation and envisioning[2,3].

> *Observation:* The ability to become actively aware of the experience of looking, and to be able to learn from looking. Example questions that focus on observation might be: "What in this design catches your eye first, and becomes the focal point? How does this design guide your eyes around the page?"
>
> *Envisioning:* The ability to imagine changes that could be made in a visual design, and assign meaning and evaluation to those potential changes. Example questions that focuses on envisioning might be: "What is the least necessary component of this design? If that component was left out, how would it change the effect of the design to you?"

These practices of observation and envisioning are also what helps an engineer to hone the ability to express information and meaning well through extremely open-ended formats like figures, PowerPoint presentations, and posters. Yet engineering students have limited opportunity to build observation and envisioning skills for visual design within their engineering curriculum. When we look to visual arts curriculum as an inspiration for teaching these skills to engineering students, we see that one of the most enduring pedagogical means for educators to sharpen these habits, as well as connecting students with others' negotiated assessments, is through group critique or simply, the "critique"[2].

The critique

There can be many formats for the critique, ranging from casual small-group discussions of peer work to high-pressure class-long focus on a single work featuring peers, instructors, and clients[2,4–6]. Speaking generally, critiques have two essential features[2]: First, they are focused on student work and work process, such that the student presenting the work receives formative feedback and information about how a work is perceived by an audience. Second, critiques are explicitly social; they involve not only assessment, but open discussion and negotiation of a group's often-conflicting opinion of work. Thus, students who critique a peer's work learn by the reflection required to observe and envision changes, but also by understanding and even arguing with peers' different approaches and interpretations, and articulations thereof.

A case for guided critiques

Critics of standard studio critiques in higher education note that showing work to others for formative assessment often makes a student feel vulnerable, and negative critiques can be demoralizing[4,6]. Students also often defer to their reviewers' suggestions without engaging with them or making meaning out of them, in order to attain better grades[5,6]. And though students prefer to receive honest and straightforward critiques, they are not all yet in a position to give it; there is great variation in both participation and quality of feedback among peer discussants[6].

These drawbacks are reminiscent of similar ones within peer-to-peer review activities in writing courses. Among writing educators, these shortcomings are often mitigated by providing more scaffolding within the peer review activity itself. Recommended practices include providing students with guiding questions to help them focus on important feedback[7]; instructing students to report and describe their experience of the work, rather than evaluate it or provide suggestions[8]; and discussing explicitly the role and conduct of the student being reviewed as well as the role and conduct of student reviewers[9]. These techniques for guiding students to give constructive critiques transfer easily to group critiques of visual design. Undoubtedly, many educators have already put them into practice in their art and visual design classrooms.

The introduction of principles of design

Ideally, a student should be able to construct a sense of design from observations and envisionings, guided a bit by social learning. In reality, this takes years to master even for dedicated students of visual design. To scaffold this process, students in visual arts fields are often given design principles to help them make meaning of their own experiences as consumers and creators of visual design. In effect, these principles provide both a model and a head start on the students' work toward observing and envisioning. And despite the subjective and negotiated nature of visual design evaluation, design principles are considered to be relatively universal; in effect, they point to underlying cognitive mechanisms that most of us utilize when interpreting visual stimuli. Design principles facilitate transference of visually constructed knowledge across visual design genres and media.

In this work, we use and adapt the critique to provide students with a fundamental learning experience that scaffolds observing and envisioning, toward the creation of effective figures. To help them complete the activity, we provide them with a brief set of adapted design principles, drawn from visual design[10], data communication[11], and an assessment of previous years' figures from bioengineering capstone reports.

Participants

Bioengineering senior undergraduates at the University of Washington participate in a capstone design course, in which most of the project work is done in laboratories, but students also meet as a group once a week throughout the academic year. We utilized one of the spring quarter class meetings for our workshop. Students were asked to prepare by bringing a draft of a figure that they intended to use in their Capstone report, which is due at the end of spring quarter.

Workshop design:

Our workshop was 90 minutes in length. We presented three design principles for students to use toward assessing and providing feedback to one another in small groups, and expected to spend approximately twenty minutes on each principle (Figure 1). In order to give students an opportunity to apply design knowledge soon after constructing it, our workshop was designed to contain a number of cycles of uncovering a principle, and then applying that principle toward peer assessment and feedback.

1. **Discussion/uncovering of design principle.** The workshop facilitator guided the class, as a whole, to observe and comment on their experience as readers of a collection of figures and data visualizations. Through this discussion the facilitator posed both observation and envisioning questions to the students, so that each principle became evident from students' own experiences before the facilitator revealed the principle.
2. **Peer review: discussion of roles, and expected conduct.** Before commencing small-group critiques, the facilitator discussed the role of both the readers and the critiquers during small-group peer activity. The facilitator posed the activity as an opportunity for the figure's designer to collect user data, and asked the critiquers to offer information about their experience reading the figure.
3. **Guided questions; 5-10 minutes of peer review.** The facilitator asked the students to break into groups of approximately four in order to discuss figures. The facilitator presented a series of questions related to the previously-revealed design principle, to guide discussion and ensure that students focused on providing meaningful feedback.
4. **Repeat discussion, uncovering of new principle, and peer review.**
5. **Reflection for figure designers.** The facilitator concluded the workshop by asking figure designers to consider the information they'd gained by discussing their figures with their peers, and reflect upon how that information might guide their future work on figures.

Design Principle	Guiding Questions for Peer Critique
1. Every figure should support a cognitive function of the reader.	• What cognitive task is this figure supposed to help me to do? What am I supposed to learn, or understand, or see? What can I do as a result of this figure? • Was it easy to figure out what this figure's cognitive purpose is? Which aspects helped me, and which did not?
2. Figures are more powerful when they show relationships, especially comparisons and contrasts.	• What relationships does this figure use to help me understand data? • Are there other relationships I'd like to see to help me better understand or explore this data?
3. Figures should integrate elements seamlessly to showcase and support data. 3a. A figure can and should use multiple graphical modes of providing information. 3b. A figure should use parallel structures and continuity where possible. 3c. A figure draws attention to data, not to the figure itself.	• What elements/modes are combined to help showcase data? (Words, graphics, images, numbers, texts, other?) • Is information where I need it to be? • What elements of the figure are especially helpful in allowing me to focus on data and explore it?
Reflection on figure design and peer critique data	• What is the most important thing you learned from responding to others' figures? How will you make use of that information as a designer? • What is the most important thing that you learned from users' reactions to your figure? How will you apply that information? • Identify one aspect of your figure that was helpful/useful/successful with your users. How will you carry that success forward?

Figure 1: Design principles, reflection, and associated guiding questions.

Assessment Results

Student Survey

Methods: After completion of the figures workshop, students were asked to fill out a survey during a subsequent capstone class meeting. Students were told that the instructional team was interested in obtaining feedback on particular aspects of the workshop, their responses would remain anonymous, and participation in the survey was voluntary. Surveys were completed by 66% of workshop attendees (23/35).

Results: Students provided feedback on their perceptions of the effectiveness of the workshop (Figure 2). Students responded overall positively, with an average rating for most questions above a neutral rating of 3.0. The contribution of the peer review component to student learning rated lowest of all the assessment statements (average rating = 3.0, median/mode = 3), and the majority of student explanations regarding this rating cited that they needed more time for peer review.

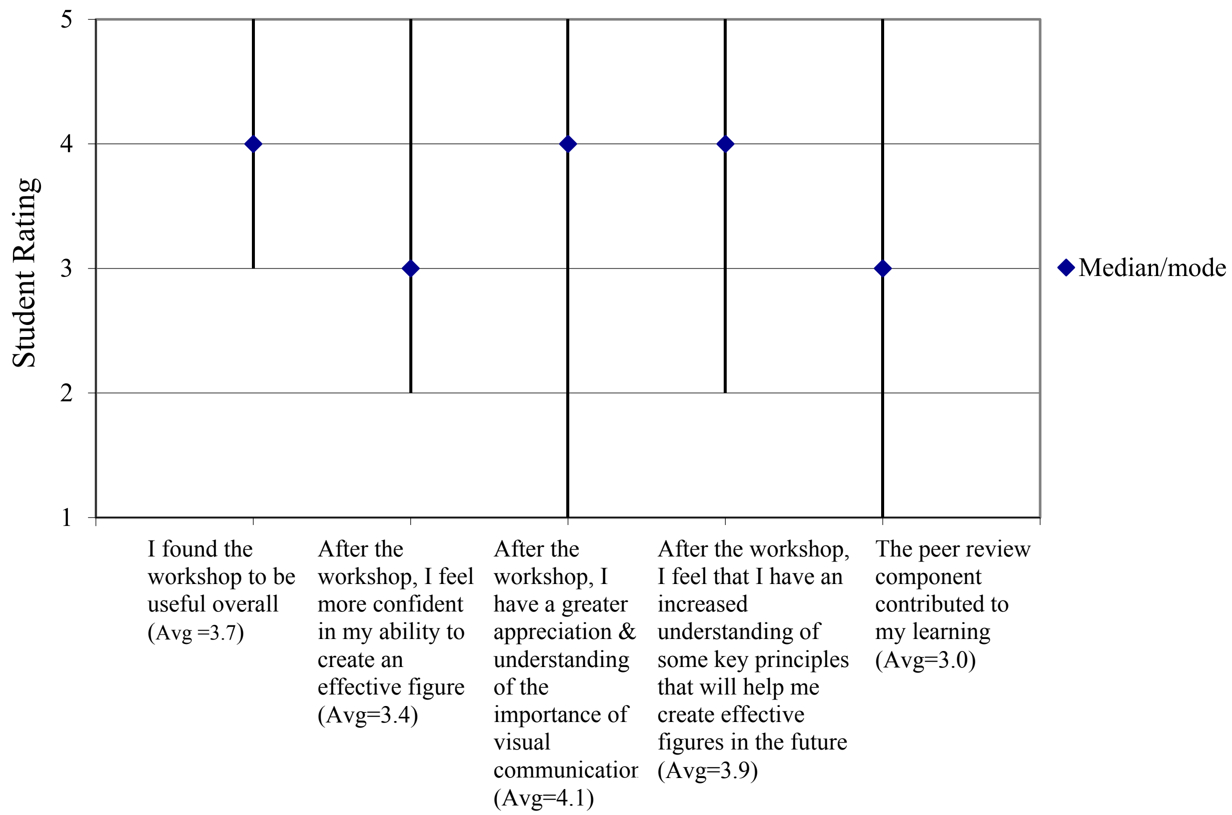

Figure 2. Ratings submitted by students in response to questions regarding their perceptions of the workshop. Ratings are on a Likert scale: 5 = strongly agree, 1 = not at all. Data are displayed as median/mode +/- the maximum and minimum ratings. Average ratings for each statement are included in the x-axis labels.

Students were asked to identify aspects of the workshop that contributed to their learning. The discussion during the workshop of figure examples was most commonly-cited by students as being helpful. The peer review component and the informational content of the workshop were also described as being useful. The presentation by the facilitator was cited as a positive aspect, as well as the requirement that students had to prepare a figure ahead of time and bring it to the workshop, because it forced them to practice.

Towards our efforts of continual improvement, we were also interested in gathering feedback from the students regarding what changes could be made to improve their learning. Key suggestions included adding more time and emphasis on peer review, increasing the structure given for the peer review component, increasing emphasis on the presentation and class discussion of figure examples, and adding more information about the process of figure building.

Interestingly, there seemed to be a class split between students who found the class discussion on figures very useful and thus wanted more time for discussion of examples and those that wanted more time for peer review. Only a couple of students made a strong argument to deemphasize the presentation aspect in favor of peer review or cut down on peer review in favor of presentation. Instead, most students asked for more time for whichever aspect they found either to be especially helpful and/or too rushed.

Direct Assessment

Methods: To investigate whether participation in this new workshop was correlated with changes in the quality of capstone report figures, we implemented a strategy of blinded review. Two reviewers independently evaluated figures from anonymized, randomly-selected capstone reports and scored each figure on a variety of dimensions using a customized rubric (see Appendix 1). Ten reports were reviewed from each of the two years examined, 2013 and 2014. Each figure of the report was scored and contributed to the average score for each dimension of each paper. Scores were compared using a t-test, with statistical significance accepted at a P value ≤ 0.05.

Results: Evaluation of figures from reports before and after workshop implementation highlighted aspects of figure development (Table 1). In particular, evaluators noted an improvement in figure captions, in terms of supporting and clarifying the figures' messages. A dominant theme in reports written before the workshop was that the onus was on the on reader to extract the figure's message using information from the surrounding text, and the caption did not support or clarify or had insufficient information. After the workshop, both reviewers noted the figure captions were more likely to be helpful and contribute to the reader's understanding of the figure's message (significant difference for one reviewer, $P = 0.014$). Average scores for figure clarity, legibility, and professionality improved from year 2013 to 2014. Also nearing a statistically significant improvement from 2013 to 2014 was the inclusion of key information in the figure that helped the reader interpret meaning (i.e. labels, legends, keys, highlighted data) without having to refer exhaustively to the surrounding text or caption.

In the workshop, we emphasized the importance of designing and including figures that had meaning and purpose. Each figure included should contribute to the overall story of the paper. Interestingly, the message appeared to resonate with the students. Capstone reports submitted after implementation of the workshop contained fewer figures (Figure 3). The difference in the number of figures included in the Capstone reports sampled from 2013 (before the workshop) and 2014 (after the workshop) was statistically significant ($P = 0.034$).

Table 1. Direct Assessment of Capstone Report Figures from 2013 (pre-workshop) and 2014 (post-workshop). Figures were scored as 1, 2, or 3 (1 = unsatisfactory; 3 = figure is excellent with regards to that dimension). *Statistical significance accepted at P-value ≤ 0.05. Data displayed are the average score and standard deviation for each reviewer.

Scoring Question		**2013 Avg Score (SD)**	**2014 Avg Score (SD)**	**P-value** (comparison between 2013 and 2014)
Is the figure clear, legible, and professional?	Rev1	2.1 (0.62)	2.4 (0.44)	0.179
	Rev2	2.0 (0.08)	2.2 (0.34)	0.068
Is the main message/cognitive function of the figure clear?	Rev1	2.3 (0.42)	2.5 (0.41)	0.383
	Rev2	2.0 (0.07)	2.0 (0.07)	0.292
Does the figure complement/supplement the text?	Rev1	2.3 (0.33)	2.2 (0.71)	0.842
	Rev2	2.0 (0.14)	2.0 (0.18)	0.463
Is the figure callout formatted in the text properly?	Rev1	1.6 (0.58)	2.0 (0.69)	0.177
	Rev2	1.8 (0.36)	2.0 (0.53)	0.279
Including the caption, can you quickly understand the figure's "story" (independent of text)?	Rev1	2.0 (0.38)	2.3 (0.38)	0.075
	Rev2	1.7 (0.23)	2.0 (0.22)	*0.014
Are important relationships shown?	Rev1	2.1 (0.34)	2.2 (0.41)	0.371
	Rev2	1.9 (0.26)	2.1 (0.25)	0.309
Does figure make use of multiple modes of visual storytelling (e.g. graphics, text, photos, arrows/lines, colors, annotations etc.)?	Rev1	2.1 (0.39)	2.2 (0.41)	0.454
	Rev2	1.9 (0.24)	2.0 (0.22)	0.262
Does the figure place information where it is needed?	Rev1	1.9 (0.46)	2.1 (0.41)	0.344
	Rev2	1.6 (0.30)	1.9 (0.40)	0.074
Does the figure use devices like parallel structure and axes continuity in order to facilitate comparisons and contrasts?	Rev1	2.2 (0.52)	2.0 (0.45)	0.352
	Rev2	2.0 (0.12)	2.0 (0.13)	0.642

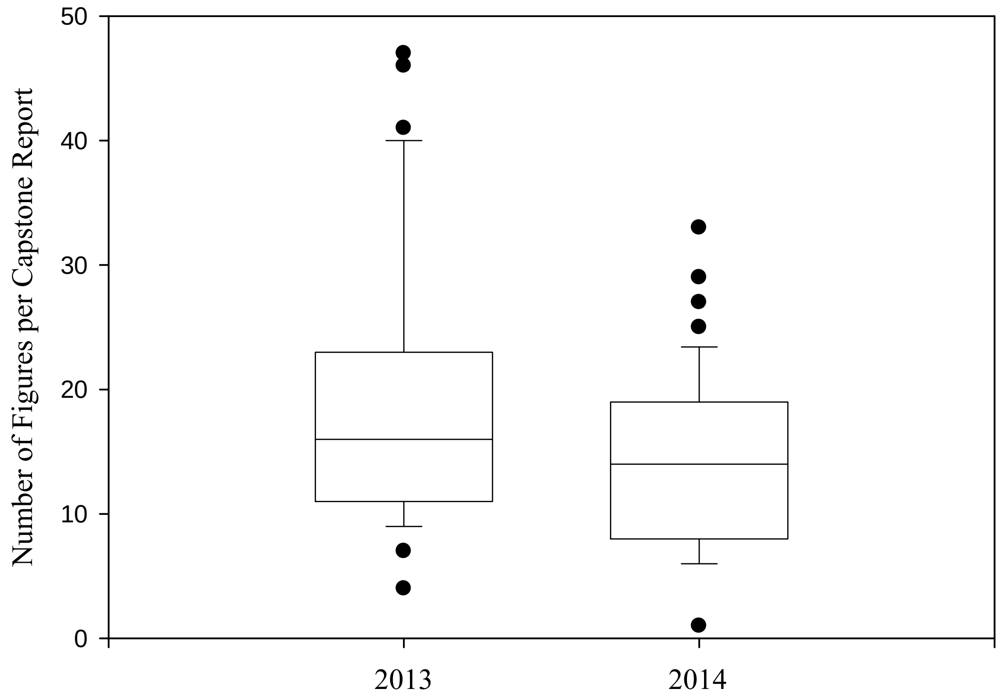

Figure 3. Capstone reports submitted after workshop implementation contained a fewer number of figures. The difference in the number of figures included in the reports sampled from 2013 (before the workshop) and 2014 (after the workshop) was statistically significant. Data analyzed using Mann-Whitney Rank Sum test ($P = 0.034$).

Discussion

Student ratings and comments suggested that students found the workshop to be helpful. The positive student ratings certainly echoed the energy of the workshop itself; many students were eager to take part in the discussion of figures and figure principles, and seemed to relish the opportunity to develop and express an opinion about figure design.

A particular highlight of the class discussion was when the facilitator presented a single data series expressed through several different figures. The student participants were eager to discuss the differences between two of the figures, and discuss which one they felt told a better story with data. Through this discussion, students seemed to have little trouble understanding and accepting that a figure could not be evaluated on an absolute scale, beyond a certain threshold of clarity and function. They engaged readily with the idea that changes in a figure's design implied changes in how a reader interacted with it and what story a reader might see in the data. Thus, students displayed both observation and envisioning during the discussions of design principles.

Students also showed a measure of improvement in their decisions regarding figures from one year to the next. The students who participated in our workshop seemed to have particularly improved in telling a story clearly within their figures and captions as compared to the previous cohort. Students also displayed improvement on multiple measures, including clarity, legibility, and inclusion and proximity of key information; these effects became more statistically relevant when outliers were excluded. A larger sample size might help to establish these relationships more clearly. Students also showed a clear trend toward reducing the total number of figures in their papers. This is significant because the number of figures included in each paper strongly predicted signal-to-noise within the figures; when reports contained more than 16 figures, the excess figures often added no useful information to the capstone report but instead seemed to only provide an artifact of the student author's work. A reduction in total number of figures among students who completed the workshop suggests that students considered whether given figures would truly add meaning to their reports, or whether it would just provide distracting information.

It is important to note a significant confounding factor in our efforts to assess student learning by evaluating their completed figures. It is clear when reading capstone reports that many of students' figures are not created by students themselves; they are graphics that have been generated by the lab in which the students apprentice, and which students have been encouraged to use. This sharing of graphics is typical of laboratory collaborations, and often a lab expects to make multiple uses of information visualizations in which they've invested much time and effort. Because a student's final grade is assigned by his or her lab advisor, it makes strategic sense to use the lab's graphics if offered, and make limited changes both out of respect to the lab's work and to avoid reinventing the wheel. In both 2013 and 2014, all student reports contained a significant plurality, if not a majority, of figures that appeared to be the stock of the students' labs rather than the student's original design.

Conclusions and Future Work

Given the positive reception of the students, and the notable changes between the two cohorts' figures decision, the critique seems to have provided a worthwhile learning experience to engineering students who might not otherwise receive any instruction in visual design. Students participated in discussions that required them to exhibit observing and envisioning behaviors, and provided meaningful feedback to one another by applying those behaviors.

In future offerings, we would make the following adjustments to help students learn. First, the room layout has a significant bearing on the ability of students to talk with ease in a group, and to transition readily from a class discussion to a small-group discussion. We would ensure that this workshop occurs in a room with a type of seating that facilitates student groupings.

Second, we somewhat underestimated student interest and attention span for the topic of graphic design. Initially we supposed that we might have to couch the lecture exhaustively in the language of user-interface design to supply the topic with engineering ethos, but this was not the case at all. Students displayed significant engagement and interest in the material and content of the design principles. They discussed design animatedly as a class; many requested a longer lecture or more time for peer critique. In fact, on more than one occasion the facilitator had to cut short an interesting student-initiated discussion point to ensure that all of the workshop content could be covered. In light of this, we would structure the workshop to reduce the amount of time spent transitioning from full class discussions to small-group discussions to preserve more time for meaningful discussion. In our future offerings we will simply have a full-class discussion about design principles, reiterate the roles of designer and reviewer in peer critique, and transition to a small-group activity.

There is both qualitative and quantitative evidence that the critique provided a novel aspect to their engineering communication education, and students are willing to engage with the topic. However, presenting this visual design workshop in the last quarter of their senior year underscores how little time engineering students have to construct their knowledge of qualitative, design-based visual communication skills before they are asked to perform them in their professional careers. In order to provide students with better scaffolding for building this knowledge, students should have earlier and more frequent exposures to learning that scaffolds their ability to make meaning of their qualitative experiences and translate that meaning into design. Future work will include designing a larger constellation of these communication design learning experiences for students during their senior capstone.

Bibliography

1. Sheridan, K. M. Envision and Observe: Using the Studio Thinking Framework for Learning and Teaching in Digital Arts. *Mind, Brain, Educ.* **5,** 19–26 (2011).

2. Hetland, L., Winner, E., Veenema, S. & Sheridan, K. M. *Studio Thinking 2: The Real Benefits Of Studio Art Education*. 164 (Teachers College Press, 2013).

3. Sandell, R., Education, A., Burton, J. M. & Beudert, L. What Excellent Visual Arts Teaching Looks Like. *Advocacy White Pap. Art Educ.* (2009).

4. Percy, C. critical absence versus critical engagement : problematics of the crit in design learning and teaching. *Art, Des. Commun. High. Educ.* **2,** 143–154 (2000).

5. Horton, I. The Relationship between Creativity and the Group Crit in Art and Design Education The Relationship between Creativity and the Group Crit in Art and Design Education. *Creat. or Conform. Build. Cult. Creat. High. Educ.* (2007).

6. Blair, B., Blythman, M. & Orr, S. “Critiquing the Critique”: A 2 year ADM-HEA funded project. (2008). at <http://www.adm.heacademy.ac.uk/projects/adm-hea-projects/learning-and-teaching-projects/critiquing-the-crit/index.html>

7. Using Peer Review to Help Students Improve Their Writing. *The Teaching Center, University of Washington St. Louis* at <http://teachingcenter.wustl.edu/strategies/Pages/peer-review.aspx#.VM6713aOe18>

8. Using Peer Review to Improve Students' Writing. *Gayle Morris Sweetland Center for Writing, University of Michigan* at <http://www.lsa.umich.edu/UMICH/sweetland/Home/Downloads/UsingPeerReviewtoImproveStudentWriting.pdf>

9. How to Plan And Guide In-Class Peer Review Activities. *The Teaching Center, University of Washington St. Louis* at <http://teachingcenter.wustl.edu/strategies/Pages/peer-review-how-to.aspx#.VM6_KnaOe18>

10. White, A. *The Elements of Graphic Design*. 224 (Allworth Press, 2011).

11. Tufte, E. *Beautiful Evidence*. 213 (Graphics Press, 2006).

Appendix 1: Rubric used to evaluate capstone report figures

Scoring Question	1	2	3
1. Is the figure clear, legible, and professional?	Unsatisfactory; text is unreasonably small (below 8pt) or resolution is poor; figure is not neat, or has been resized without editing properly.	Satisfactory; figure is legible, has limited computer artifacts (i.e. pixellation), and is in line with the intended standard graphics of software used to create it (e.g., it is a basic Excel plot at an appropriate size)	Excellent; figure is professional and easy to read; figure has nonstandard features that help its legibility or clear presentation that imply extra care in design (for example, an Excel plot with tailored formatting/axes, or additional labels added in Illustrator)
2. Is the main message/cognitive function of the figure clear?	Unsatisfactory; it isn't clear what the figure is trying to convey or do for a reader.	Satisfactory; the basic reason for the figure's inclusion is clear	Excellent; the figure's purpose is very clear, and contributes an important facet to the overall story of the paper.
3. Does the figure complement/supplement the text?	No; the callout sentence is nonsequitur to figure citation; or figure does not help text and is off-topic.	Satisfactory; the figure is referenced	Very well; adds or clarifies something very relevant to text
4. Is the figure callout formatted in the text properly?	No; figure callout is missing, or incorrectly labeled/numbered.	Satisfactory; figure callout was present, functional; perhaps formatted so that Figure is in subject or has other formatting issues.	Excellent; figure callout was subordinate to message, after appropriate phrase.
5. Including the caption, can you quickly understand the figure's "story" (independent of text)?	No; onus is on the on reader to extract message; caption doesn't support or clarify, or has insufficient information.	Satisfactory; takes a reasonable amount of time to understand the figure's message; caption is helpful.	Excellent; figure's message is easy to understand, OR figure clarifies/explains complicated relationships; caption provides excellent guide to figure, but not irrelevant or confusing information.
6. Are important relationships shown?	No; there is obvious relationship data (such as scales) that should be in figure but are not; or figure doesn't help to understand relationships in data it reports	Satisfactory; relationship shows enough information to support its (presumed) cognitive function	Excellent; figure shows relationships clearly; or creatively; or design is clear enough for reader to easily discern relationships from rich data. Statistical information shown in graphs as relevant.
7. Does figure make use of multiple modes of visual storytelling (e.g. graphics, text, photos, arrows/lines, colors, annotations etc.)?	No; an additional mode (like a label) is obviously warranted to explain data; OR, modes used do not help to clarify data and instead are distracting or misleading.	Satisfactory; figure uses an appropriate or standard mix of modes, sufficient to support visual communication required for (presumed) cognitive function of figure	Excellent; figure uses an enhanced, nonstandard, or creative set of modes to add richness and ease of understanding to the figure.
8. Does the figure place information where it is needed?	No; figure requires information from embedding text in order to be interpreted; or information is buried in caption such that a reader has to refer exhaustively and constantly to the caption in order to interpret information. (e.g., no labels except in caption.)	Satisfactory; the figure has a standard legend or key; or the figure makes important information visible in expected places; not too much iteration between legends. Significant trends (such as P values) might not be shown or highlighted.	Excellent; figure places important information directly on graphic (for example, with custom labels); reader has to do little repetitive/iterative searching to understand figure (little eye movement required to capture story). Significant values and trends are highlighted.
9. Does the figure use devices like parallel structure and axes continuity in order to facilitate comparisons and contrasts?	Unsatisfactory; figure is missing obvious comparative information (for example, figure of diseased cells with no reference photo of healthy cells; or, inconsistent units and axes between two quantities that should be compared).	Satisfactory; figure provides comparisons or sequences or parallel structures where they are most obviously warranted. Comparative elements are sufficient to make the figure functional.	Excellent; figure utilizes comparative devices to help illustrate points and convey key results; comparative devices are well-considered and helpful, and improve design of figure toward its cognitive function.