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AGRO/HORT 403/803: Scientific Writing and Communication—A Peer Review of Teaching Project Inquiry Portfolio

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Course Portfolio

Scientific Writing and Communication
AGRO/HORT 403/803

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Abstract

Scientific writing is a skill that is useful for science students, since many of them will write about their research in a thesis, dissertation, or in journal articles. The goal of my course is to provide students with practice and training in scientific writing so that after they take the course they are confident and ready to write drafts independently. The class uses many learning activities, such as reading, writing, peer reviewing, revising, and class discussions. However, the first two iterations of the course did not have built-in ways to practice sentence and paragraph editing, or to gauge quality of peer reviews. This portfolio addresses two inquiry questions: 1) “How can I incorporate collaborative editing exercises into class?” and 2) “How can I document the quality of student peer reviews?” Collaborative editing was conducted using small groups and Google Docs files. Information in student peer reviews was captured by one-page forms that students provided along with marked-up drafts. Both additions to the course were considered to be successful based on student feedback and instructor evaluation. This portfolio also analyzed multi-year survey data regarding the most effective class activities and student confidence in scientific writing.

Keywords: scientific writing, peer review, survey, collaborative editing, revision

Table of Contents

Abstract
Introduction
- Background
- Lessons from the first two course offerings
- Inquiry research questions

Methods
Results and Discussion
- Pre-course and post-course test
- Activities rankings
- Student confidence
- Peer reviews and collaborative editing

Conclusions
Appendices
- Appendix 1: Syllabus
- Appendix 2: Student quotes about the most effective class activities

INTRODUCTION

Background

My course is called “Scientific Writing and Communication” (see **Appendix 1** for syllabus). This course is an ACE10 (Achievement-Centered Education, level 10) course in which students “Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection”. It is also a capstone course for two undergraduate majors in the Agronomy and Horticulture department: Plant Biology and Horticulture (Plant Science option). The course is also open to graduate students. Over three semesters of teaching this class (Table 1), I have had 10 undergraduate and 29 graduate students, from 10 majors, with a slightly higher number of male students than female students. Students are expected to have performed an original research project, and during the course they will use their own project methods and results to write the manuscript. On two occasions, an undergraduate student needed to take the course as a capstone but did not have results, and in those cases a dataset and methods were provided for the student to write about.

Student Demographics:	**2014**	**2015**	**2016**	**Total**
Undergraduate students	5	3	2	**10**
Graduate students	5	9	15	**29**
	2014	**2015**	**2016**	**Total**
Male	4	7	11	**22**
Female	6	5	6	**17**
Majors:	**2014**	**2015**	**2016**	**Total**
Agronomy	2	6	8	**16**
Horticulture	3		2	**5**
Plant Biology	2	2	1	**5**
Agricultural and Biological Systems Engineering		2	2	**4**
Food Science	1		2	**3**
Biological Systems Engineering	1	1		**2**
Biology	1			**1**
Computer Science			1	**1**
Mechanical Engineering			1	**1**
Plant Pathology		1		**1**

Table 1. Student demographics in AGRO/HORT 403/803, Scientific Writing and Communication, in Spring Semesters 2014, 2015, and 2016.

The course has three phases. In phase 1, students learn to read and critically evaluate scientific literature in Plant Biology. In phase 2, which is the bulk of the course, students write a research paper based on their own original research, and peer-review research papers of fellow students. In phase 3, students prepare their research in a poster format and present it to the class. Specific learning objectives are:

1. Identify and recommend appropriate sources of scientific research information (e.g. peer-reviewed journals)
2. Appraise and critique the methodology, results, and interpretations in scientific writing

3. Be able to clearly and simply state the hypothesis and/or research goal(s) and specific objectives of their project
4. Assemble results of experiments, compose figures and/or tables, organize manuscript in standard scientific format, and provide interpretations in the context of existing knowledge
5. Prepare a research poster and deliver a poster presentation for a general scientific audience

The course has 12 class activities. The first phase of the course contains three of the class activities: **1)** reading journal articles ("example papers") and **2)** discussing these journal articles as a class. As part of the study of these papers, the students **3)** fill out a "reader/writer" form, which can also be used later, as the students write their drafts. As we move into the second phase of the class, students **4)** search scientific literature databases for papers related to their work and read these papers. It is during this time I begin the next activity, **5)** class lectures with PowerPoints that the students can access for later use. They are also assigned **6)** textbook reading as we go through the chapters, and are provided with **7)** links and extra articles on Blackboard.

After I give my lecture on each section of a scientific article, the students **8)** write their drafts. These are turned in to me and to three other students, who **9)** read the peers work and **10)** edit/review the writing and make comments and suggestions. The students then **11)** revise their drafts using comments from me and from their peers. After the first final draft, the students are then asked to **12)** do a reverse outline of their paper to see if structural changes would improve it.

Lessons from the two course offerings

In most aspects, the first time I taught this course it was a success. No major problems arose, and the students improved in both scientific writing knowledge and in scientific writing skill. Scientific writing knowledge was determined by a pre-course test and post-course test, and scientific writing skill was determined by changes in error frequency between first drafts and final versions. A student survey indicated overall satisfaction with the course and helped me learn about several specific aspects. Despite this success, I was still not exactly sure which class activities were most effective for student learning, information that is crucial for setting the best class schedule. The students were asked to rank effectiveness of class activities to determine which activities were most valuable.

I also learned about several former graduate students in our department who dropped out of the program rather than write a thesis, because the writing process was too intimidating to them. This lack of confidence/intimidation factor can be contagious. In the second year I added questions to the first- and last-day surveys to test whether student confidence in writing ability increased after this course.

Survey results from the first two years indicated that “revising” and “writing” were the two most effective class activities, followed by “class lectures and PowerPoints”. In 2015, student confidence in scientific writing improved by about 66%.

Inquiry Research Questions

Research Question 1: What is the most effective activity in my course for student learning?

Research Question 2: Does this course increase student confidence in scientific writing?

Methods

All students signed informed consent statements allowing me to collect data.

To test for improvement in knowledge of scientific writing, I had the students take a 24-question quiz on the first day of class (pre-course) to establish their baseline knowledge of scientific writing principles. On the last day of class, they take the same quiz again (post-course).

I gathered data was from two surveys. The first day of class survey included five questions to gauge preparedness of the students. I then asked three questions about their confidence levels for a) reading and analyzing scientific literature, b) finding and citing appropriate literature, and c) writing a scientific manuscript. I also asked students to list three goals for themselves for the class, and asked which specific aspects of scientific writing they felt like they needed to improve.

In the final week of class, I gave another survey. The first part presented a series of statements about the course in general, with which students indicated their agreement or disagreement on a 5-point scale from “strongly disagree” to “strongly agree”. In a separate section, students were asked to rank the effectiveness of the 12 class activities outlined above and explain their top two choices. Another section of the survey repeated the confidence questions from the first day survey. Another section asked them to rate their improvement in specific areas that aligned with the first day survey goals and improvement target areas.

To document and evaluate student peer reviews, I developed one-page forms for the reviewers to comment on key scientific writing principles. There was one form for each section of the paper; Introduction, Materials and Methods, Results, Discussion, and Abstract and Title. The reviewers filled out these forms in addition to marking up the drafts. Before the forms were returned to the authors, I scanned them into a single PDF for archival and evaluation.

To perform collaborative editing exercises, I found examples of scientific writing that would benefit from editing, and put these example texts into Google Docs files. The class was divided into six working groups, and each group had access to a Google Docs file. During class, the groups discussed what aspects of the text needed to be edited and decided how to make the edits. The original texts and the edited versions from each group were analyzed for readability using “The Readability Test Tool” (http://www.webpagefx.com/tools/read-able//).

Results and Discussion

Pre-course and post-course test

The mean scores on the post-course test increased by a statistically significant margin each semester, as compared to the pre-course test (Fig. 1, Table 2). There was no special preparation for the post-test, and the students did not have access to the questions between tests, so I am confident that the improvement represents actual learning of scientific writing principles.

Table 2. Pre-course and post-course test results.

Year	Pre-course	Post-course	Change (%)	*p*-value
2014	11.3 ± 1.6	15.1 ± 2.1	33.6	<0.001
2015	13.1 ± 2.9	17.5 ± 2.8	33.8	<0.001
2016	11.8 ± 1.3	16.4 ± 2.7	39.0	<0.001

Fig. 1. Pre-course and post-course test results, averaged across 2014, 2015, and 2016.

Activities rankings

The three-year survey results indicated that the components of the course were effective (Fig. 2). All students agreed or strongly agreed that the course was useful to their overall education, they would recommend the course to their peers, and their ability to read and evaluate scientific papers had improved. Important to the ACE10 status of the course, all students agreed or strongly agreed that their knowledge of scientific writing and their skill in scientific writing had improved. Student quotes about the top activities from 2015 and 2016 are shown in **Appendix 2**.

Please indicate how strongly you agree with the following statements:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The instructor reviews/edits of my drafts were helpful				8	92
After this course, my knowledge of scientific writing has improved				24	76
This course has been useful to my overall education				34	66
I would recommend this course to my peers			3	32	66
The peer reviews/edits of my drafts were helpful			13	26	61
Using the reader/writer form improved my ability to read and understand scientific papers		4	7	33	56
Discussing the four example papers was helpful		5	5	34	55
After this course, my skill in scientific writing has improved				47	53
The in-class writing time was useful		8	16	32	45
After this course my ability to read and evaluate scientific papers has improved				55	45
Editing my peers' writing helped me learn about scientific writing			3	68	29
Reading the four example papers was helpful		3	5	50	42
Using the reader/writer form improved my ability to organize and write my scientific paper.		4	11	48	37
The order of the topics should not be changed	3	5	16	42	34
Reading about research of my peers helped me learn about plant science	5	5	26	34	29
The textbook for this class was useful	5	5	32	45	13
More time on example papers' structure would have been helpful		29	34	32	5
The pace of the course was too fast	13	45	29	11	3
The pace of the course was too slow	18	58	24		
The in-class writing time encouraged me to wait until class time to begin writing	24	39	21	16	

Fig. 2. End-of-semester survey results from 2014, 2015, and 2016. Numbers are percentage of student answers per category.

The usefulness of some of the class activities was indicated in Fig. 2, however, this information does not explain which activities are the *most* effective. The aggregate results of student rankings of class activities from the first three years are shown in Fig. 3. It was clear that two activities were the most highly effective: “Revising my drafts using peer/instructor comments” was ranked first, and “Writing my drafts” was ranked second. Interestingly, the undergraduate students ranked the mid-range effectiveness class activities differently, potentially reflecting the greater experience in reading and writing for the graduate students.

Class Activity	2014 Overall Ranking	2015 Overall Ranking	2016 Overall Ranking	Combined Overall Ranking	UG Ranking	Grad Ranking
Revising my drafts using peer/instructor comments	2	1	1	1	1	1
Writing my drafts	1	2	2	2	2	2
Class lectures and powerpoints	9	3	3	3	4	3
Discussing the four example papers	3	5	4	4	3	6
Searching for and reading papers to cite	5	4	5	5	6	4
Reading the four example papers	7	6	9	6	7	5
Reviewing/editing my peers' work	4	7	8	7	5	9
Using the reader/writer form	(NA)	10	6	8	9	7
Reading my peers' work	6	9	7	9	8	8
Textbook reading	10	8	12	10	11	11
Reverse outlining	8	12	11	11	10	12
Links and extra articles on Blackboard	11	11	10	12	12	10

Fig. 3. Effectiveness ranking survey results. Overall results are shown for each year. Rankings by undergraduates (UG) or graduate students (Grad) are shown on the right.

Student Confidence

On the first day of class in 2015 and 2016, students mostly indicated that they were “somewhat” or “moderately" confident in their ability to read and analyze a scientific paper, or find and cite appropriate literature. The confidence ratings were even lower for ability to write a scientific paper, with most marking “somewhat” or “not at all”. However, on the last day of class, most students marked “quite” or “very” confident for all three tasks, indicating a substantial improvement in confidence. Thus, the percentage of students that were “quite” or “very” confident increased by 49-66% during the course (Fig. 4).

	Not at all	Somewhat	Moderately	Quite	Very
How confident are you in your ability to *read and analyze* a scientific paper right now?	-3	-23	-32	34	25
How confident are you in your ability to *find and cite appropriate literature* related to your manuscript right now?	0	-20	-30	16	33
How confident are you in your ability to *write* a scientific paper right now?	-20	-36	-8	36	29

Fig. 4. Results of student confidence survey from Spring 2015 and 2016 combined.

I also surveyed the students on accomplishment of goals that they listed first day surveys (Fig. 5). If the students indicated improvement in these areas, I interpret this as that they will also have increased confidence in their abilities in these areas. All goals had the majority of responses in “Good” or “Great” improvement.

After this class, please rate your improvement in:	None	Small	Moderate	Good	Great
Scientific writing ability			10.7	42.9	46.4
Writing an Introduction Section			7.1	57.1	35.7
Searching for and citing sources	7.1		10.7	46.4	35.7
Making an effective scientific poster		3.6	7.1	57.1	32.1
Structuring a scientific paper to "tell a true story"			14.3	53.6	32.1
Languange/grammar/word use			28.6	42.9	28.6
Writing a Results Section			10.7	64.3	25.0
Writing a Discussion Secion			21.4	53.6	25.0
Clear and logical presentation			21.4	57.1	21.4
Understanding the scientific writing and publishing process		3.6	17.9	57.1	21.4
Writing process/productivity			12.5	68.8	18.8
Learning from journal articles		6.3	18.8	56.3	18.8

Fig. 5. Accomplishment of common goal categories in Spring 2015 and 2016.

Peer Reviews and Collaborative Editing

Students indicated that peer reviewing has been useful for their learning (Fig. 2), with 68% agreeing and 29% strongly agreeing that “editing my peers' writing helped me learn about scientific writing”. However, in the first two years of teaching this course I had no mechanism of capturing the peer reviews. The forms I developed for documenting peer review comments worked well. I was able to read student comments about their peers’ drafts, whereas with my previous peer-reviewing system I did not have a record of student reviews. By reading the reviews, I was able to gauge the quality of feedback authors were getting from their peers. I was also able to gain a sense of how well my lessons about writing each section were being followed. These forms also served a guides for the peer reviewers, letting them know what to look for and focus on while reading the drafts. In previous years, some of the less experienced peer reviewers seemed to be unsure of what to do, and I was told by other students that they mainly just corrected typos or grammar instead of suggesting edits for structure and style.

Collaborative editing exercises using Google Docs was successful, based on my observations of the group activities and feedback from students. All groups of students improved the readability of the texts, indicating that lessons on writing style were effective. An example of readability of an original and improved Introduction section is shown in Fig. 6. I will continue to offer this activity in the future class offerings.

	Original	Group 1	Group 3	Group 5	Better is:
Grade level	17	15	16	16	lower
Age	22	20	21	21	lower
Flesch Kincaid Reading Ease	18.2	23.9	24.9	20.9	higher
Flesch Kincaid Grade Level	16.9	14.4	15.2	15.2	lower
Gunning Fog Score	19.4	17.2	17.6	18.4	lower
SMOG Index	14.2	12.5	13	13.4	lower
Coleman Liau Index	17.3	17.2	16.5	17.7	lower
Automated Readability Index	17.4	14.1	15.4	15.1	lower
Text Statistics					
No. of sentences	15	14	15	18	
No. of words	371	254	329	349	fewer
No. of complex words	91	66	76	97	fewer
Percent of complex words	24.53%	25.98%	23.10%	27.79%	lower
Average words per sentence	24.73	18.14	21.93	19.39	lower
Average syllables per word	1.93	1.94	1.89	1.97	lower

Fig. 6. Example of results of group editing exercise. Grade and age level, readability indexes, and text statistics for a 3-paragraph Introduction. Scores for the original version is shown next to scores for three student editing groups.

Conclusions

The new peer review forms and group editing activity were successful additions to the class, and will be continued. My survey results indicate that all the activities that I dedicate class time to are considered to be useful by the majority of students. The survey results also indicate that the class activities lead to a substantial overall increase in student confidence. The increased confidence in scientific writing, citing literature, and reading and analyzing literature indicates

that students will have less “fear of writing” after taking this class. I hope that this will translate to higher productivity for the careers of these students. Even more importantly, I hope that this increased student confidence will result in fewer students dropping out of graduate school, either directly for students that have taken my class, or indirectly from contact with students who have taken my class and project confidence in scientific writing, or who can offer advice and encouragement to students who have less confidence.

Appendices

Appendix 1: Syllabus

AGRO/HORT 403/803: Scientific Writing and Communication (Capstone)
Spring Semester 2016 University of Nebraska

Instructor: Brian Waters
Office: 377K Plant Sciences Hall
Telephone: 402-472-0153
email: bwaters2@unl.edu
Office hours: Drop in or by appointment

Required materials:
Textbook: Scientific Writing and Communication, Second Edition, by Angelika H. Hofmann. Oxford University Press,
ISBN 978-0-19-994756-0
Access to a computer and internet, Word and PowerPoint (or equivalents), access to printer

Course Prerequisites: Senior standing or higher, science major, an ACE1 written communication course, an ACE2 oral communication course, and permission of instructor. Because students will need data for analysis and interpretation, all students must have their own original dataset, or have obtained a dataset from an advisor or other source before permission will be granted.

Course Overview: This course combines science disciplines with English and communications. Students will begin with original data/information and use the scientific theory from previous courses to interpret this data/information to generate knowledge. Through the scientific writing process, students will learn how to communicate the knowledge in a scientific context so that it becomes understanding. This requires both visual presentation in figures and tables as well as explanations through writing and/or oral presentation. This course will focus on developing literature review, writing, and presentation skills to allow students to present understanding to a broad audience. Two primary activities will require synthesis and integration: a) a final research manuscript that contains references and comparison to scientific literature and has gone through revisions and student peer review, and b) a poster presentation of student research.

403/803 Distinction: Students enrolled in 803 will have additional assignments of a) writing a cover letter for submission of their research paper to a peer-reviewed journal, and b) writing a cover letter for a job application.

ACE required material: This course will satisfy ACE Learning Outcome 10: “Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection.” Students have

opportunities to acquire the knowledge and skills necessary to achieve the learning outcome by performing literature searches, critiquing published papers, writing and revising drafts of the final research paper, peer reviewing, and preparing and presenting a research poster. Assignments used to assess achievement of Learning Outcome 10 will include the final research paper and the poster presentation.

Attendance policy: Attendance is required.

Assessment:
10% Research paper critiques - a standard format will be provided for students to critique four example papers
5% Initial outline and reverse outline, citation list assignments
10% Drafts of research paper - drafts will include each section of the IMRaD (Introduction, Methods, Results and Discussion) format paper plus the abstract and title, and a draft of the complete manuscript
40% Final research paper - complete paper, revised based on peer review
10% Peer reviewing - a standard format will be provided for students to constructively critique their peers' writing
15% Project poster - the same research as the written paper will be presented in an alternative format that is widely used at scientific conferences
10% Oral poster presentation - the revised poster will be presented to the class

Grading scale: A: 90-100%, B: 80-89%, C: 70-79%, D: 60-69%, F: <60%

Learning Objectives:
1. Identify and recommend appropriate sources of scientific research information (e.g. journals)
2. Appraise and critique the methodology, results, and interpretations in scientific writing
3. Be able to clearly and simply state research hypotheses and specific objectives, and write results and discussion that address the hypotheses and objectives
4. Assemble results of experiments, compose figures and/or tables, organize manuscript in standard scientific formant, provide interpretations in the context of existing knowledge
5. Prepare a research poster and deliver a poster presentation for a general audience

Catalog description: A course in reading and critiquing, writing, and presenting scientific information. Students use research data to compose a manuscript in standard scientific format, and prepare and present a poster to a general audience. Ethical issues in research and writing will be addressed.

Due dates: see schedule and course Blackboard page

Late assignment policy: for this type of class, it is crucial that all assignments are completed on time. Thus, late assignments will be docked 20% per day.

Academic honesty policy:

Academic honesty is essential to the existence and integrity of an academic institution. Any instances of academic dishonesty will be handled as described in the UNL Student Code of Conduct (http://stuafs.unl.edu/ja/code/).

ADA statement: Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

Course outline:

I. Scientific writing style and composition (3 weeks)
    a. Reading papers
    b. Critiquing papers
II. Ethics in research and writing (1 week)
    a. Avoiding plagiarism
    b. Ethics in citations
    c. Literature search and referencing
III. First draft of research paper (8 weeks)
    a. Introduction
b. Materials and methods
    c. Results
    d. Discussion
    e. Abstract and Title
IV. Final draft of research paper (2 weeks)
V. Making a research poster (1 week)
VI. Presenting the posters (During final exam)

Peer Review of Teaching Project: This semester, I am participating in the Peer Review Project, a University-wide, on-going program to develop methods for promoting and documenting student learning. This is a year-long process in which participants in the project (professors) put a great deal of thought into the design of a single course. One of the project's goals is to improve student learning, and we cannot accomplish this goal without student input. For the project, I will need to select several students whose work would be included anonymously in my course portfolio as an archive of student performance. These examples are important to show how much and how deeply students are learning. The completed course portfolio will be put on a project website: www.courseportfolio.org so that it can be shared, used, and reviewed by other faculty.

Appendix 2: Student quotes about most effective class activities

Revising my drafts using peer/instructor comments:

- Revising my drafts pointed me to things I might have missed or thought I know but were wrong so that was good backstopping for me and it was effective.
- One realizes where the errors are and finds ways to improve your ideas.
- To improve my writing, writing my paper and got comments from reviewers, especially from Dr. Waters, helped me a lot.
- I was afraid of writing before this class. The structure of the class helped me write and improve in a systematic way that I can replicated outside the course.
- Revising drafts was useful because it forces you to accept that mistakes happen, and I think it makes you a more honest writer.
- Revision comments pointed out specific mistakes I was making in my writing, which told me where/how to improve.
- See how people interpret your writing and how to improve that.
- Seeing what I did wrong helped because it was my topic.
- My number 2 was the revising my drafts using peer/instructor comments because the comments I received especially from Dr. Waters was a great way to improve upon my writing before handing it over to my advisor. I also learning more about my writing weaknesses.
- I learn better when I am first shown the basics and new information then have errors presented to me so I can fix them.
- The peer and instructor comments were a helpful and quick way to go back through the drafts and polish/add additional information to them.
- The powerpoints gave me guidelines to write and revise, and when revising all the rules started to be easy to understand.

Writing my drafts:

- Writing made me realize if I understood and could use what I learned in class. If I didn't I would look back at PowerPoints, peer edits, and book.
- Practice, practice, practice
- I learned by doing.
- My number 1 was writing my draft because this class was a great motivator to writing my thesis.
- Practice makes perfect. The only way to get better at writing is to write.
- The draft writing assignments motivated me to just start writing and get something down on paper, which is something I struggle with when trying to begin a paper.
- The best way to learn was by writing itself. When I wrote I applied all that I was taught in class.

Class lectures and PowerPoints:

- Brian is a good lecturer and presents information well that is easy to remember.
- I like the lectures and PowerPoints because they highlighted components of a good article without excessive, unnecessary detail. There was just the right balance between info and examples.

- Class lectures boiled everything down into a useable size.
- I learn more when someone explains things to me so the class lectures and PowerPoints for me was the most effective.
- I learned the most during these times because it was something new and engaged my brain well.
- The class lectures guided us how to write effectively; they were very effective lectures.

Textbook reading: The book helped to guide me through the process. (A good one)

Discussing the four example papers: I learned the most during these times because it was something new and engaged my brain well.

Editing my peers' work: Editing peer work gave me ideas for writing and made me think and use what we learned in class while editing.

Links and extra articles on Blackboard: Because it forced perspective on the important information for compiling a scientific paper.