Writing and Speech Instruction in an Introductory Artificial Intelligence Course*

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Abstract

Providing opportunities in both written and oral communication continues to grow in importance within the undergraduate Computer Science major. An introductory course in Artificial Intelligence that includes the ethical issues surrounding how society will respond to automation and machine learning systems in the future workplace is the perfect place to provide some instruction in writing and diction specific to computing. This paper explicates how students in a recent first course in AI became stronger writers and speakers because of this instruction.

1 INTRODUCTION

In the criteria for accrediting computing programs, the "ability to communicate effectively with a range of audiences" is imperative [5]. In the last two years at Mercer University, we have been tasked with teaching our own majors skills in writing and oral communication, which are specific to each of our disciplines within the College of Liberal Arts and Sciences. This is designed to build upon the foundational skills they acquired in the first two years of their general education courses.

1.1 Background

Assigning writing is not the same thing as giving students writing instruction. Writing is a slow, difficult, and recursive process. Writing should be repeated over and over again throughout the undergraduate curriculum for students to become better and stronger at it [3]. As Zobel indicates in his book *Writing for Computer Science*, "many researchers undervalue the importance of clarity, and underestimate the effort required to produce a high-quality piece of writing" [20].

In our college at Mercer University, we have a three-course core integrative curriculum for students in their first two years with writing instruction that includes modules on thesis development, citing sources responsibly, and structuring arguments and paragraphs. Students are also exposed to different types of writing so that once they arrive in their junior and senior level courses they are well prepared for writing, documenting, and speaking about significant research.

Although we had been assigning some writing and oral presentations throughout our computer science curriculum for many years, we had not been doing any specific instruction in these areas especially in our upper level courses. As Taffe argues, "professional writing must be taught in Computer Science courses as a continuation of the more general writing instruction of general education courses" [15].

1.2 Exposing Students to Different Kinds of Writing Early in the CS Curriculum

Ideally, writing can be taught throughout the major discipline, and begins in those early courses [8]. By including writing in any computer science course, you emphasize that "writing is important" and that "principles taught in English apply to technical areas as well" [19]. Also, students benefit when they do different kinds of writing in the major [2]. We recently introduced a lab in our CS1 course that exposes students to looking at scholarly articles and using the ACM Digital Library. In our CS2 course, we require significant documentation within the code as well as an accompanying analysis document, which defines the problem, states the input/output specifications, and provides insight into the design of the project. This document forces them to think critically about the choices behind their data structures and algorithms, as well as any relationships between classes used.

1.3 Related Work in Writing Instruction

More writing instruction within the major has been done at other peer universities with great success in recent years. At Furman University, a few lessons using scholarly articles in the first courses in the CS major have "helped reinvigorate students" and "exposed them to reading real research without having them worry about understanding everything in the article" [16]. They also have a mandatory 400-level seminar course that requires students to prepare papers from research journals and give oral presentations. Rollins College requires a Senior Capstone course in their major which exposes students to "primary sources, facilitates a close reading of those sources, and encourages students to reflect on the connections between the reading and their experiences in the major" [14].

The *SIGCSE 2018* panel "Writing in CS: Why and How?" discussed ways that writing can be brought into the major "without massively increasing the load on teachers and students". Strategies were discussed by panelists for assessing results such as "designing clear rubrics" which have shown "clear evidence of improvement in student writing in the context of project reports". Panelist Maxwell mentioned the importance of integrating five different types of writing throughout the major (analytic, code, descriptive, explanatory, and persuasive). And, panelist Minnes gave evidence that students who were required to do weekly reflections during internships showed "greater depth of integrative learning" in their writing by the end [1].

1.4 Writing Instruction in the Discipline

Most computer science professors are not trained in writing instruction. The easiest way for computing professors to facilitate this instruction in an upper level course is to spread it out using scaffolded writing assignments. By doing this, you provide "a variety of instructional techniques used to move students progressively toward stronger writing" [7]. This can be done by emphasizing the prewriting steps as well as multiple drafts. It means giving students feedback and/or doing peer review on a first draft, and then requiring them to revise their work. Another great way to scaffold is to simply require students to submit an annotated bibliography of their sources before actually beginning the writing of their research.

2 DISCUSSION

2.1 Format of an Introductory AI Course

There are many different, reasonable approaches to teaching a first course in AI. In our curriculum, the introductory AI course is offered at the junior level with prerequisites of data structures and discrete mathematics. It is an overview course which tends to explore the breadth of many areas in the field including the history of AI, search techniques, expert systems, machine learning, natural language processing, and genetic algorithms. We typically do one of these topics about every two weeks paired with a lab or assignment. Guest speakers or alumni from the field currently involved in any of the areas of AI covered are also invited into the classroom to complement the instruction.

The AI course textbook is supplemented by popular current books, which interweave many of the ethical issues and challenges in developing a unified theory of artificial intelligence. This past year these included *The Master Algorithm* by Pedro Domingos [6], *The Sentient Machine* by Amir Husain [13], and *Rise of the Robots* by Martin Ford [9]. These short, interesting books are all examples of excellent writing on AI. Reading them can help students improve as a writer and communicator. Selected portions or chapters can easily be assigned, and these books can become excellent sources to later use in their debates or research.

In the first week of the course while pondering what intelligence is, we read Alan Turing's original 1950 paper "Computing Machinery and Intelligence" where he proposes what is now known as the Turing Test [17]. To make time to facilitate the writing and speech instruction throughout the semester, some of the coverage from the textbook had to be excluded. But, "it is possible to both teach the students the important content of the course and to improve their writing and critical thinking abilities" [10].

2.2 Debates in the AI Classroom

Artificial intelligence in particular raises many ethical questions. On the first class day, I polled them on which of these questions in AI they were most interested in discussing and learning more about. The two topics that generated the most votes were used to form the scope of two in class debates we would do later in the course. The two debate topics selected were:

1. Robots, Automation, and AI will destroy low-wage and middle class jobs the world over in the next 50 years.
2. Autonomous self-driving cars will make driving safer than human-driven cars.

I asked them for suggestions on others they might like to work with in a group, and then used that information to assign them to one of four debate groups. Each of the four groups was then assigned to one side (Yes or No) of one of the two topics. I felt it was important for them to research the point of view and arguments for that particular side. In addition, they had to decide on a role they would play during the debate. For the first topic on automation, the student roles they decided on included Economics Professor, Data Scientist, Software Engineer, and Automation Engineer. The roles for the second debate on self-driving cars were most creative. They included Vice President of Autonomous Vehicles, Chief Technology Officer, Self-Driving Car Engineer for Waymo, and Environmentalist.

2.3 Oral Communication Instruction and Feedback

Students prepared well for the debates and we held them on two separate class days near midterm of the course. Each debate was structured for fifty minutes broken down into an opening statement from each participant on each side, a question and answer session, and a free form discussion with points, counterpoints, and rebuttals. The students not participating in that debate acted as members of the audience who were providing peer review on five components: their opening statement, persuasion, clarity of communication, grasp of subject matter, and teamwork. Students were asked to provide both comments and a numerical evaluation on a five-point scale for each of these components.

Prior to the debates, I taught them about *verbal citations* and their importance when giving a speech or oral presentation. Students are often not aware of the need to incorporate these types of citations [18]. Students were instructed to introduce points or quotes of someone else using phrases like "According to", "As reported by", etc. to clearly demarcate when using quotes. They were reminded "listening to a live debate is a linear process, and it is best to introduce a source before presenting information, so the audience is ready to evaluate the information with the source" [4].

Both debates were a great way to engage students and get them excited about many of the course topics. The discussions were quite lively, and included a nice interaction with questions from both sides as well as the audience members. Students listened and respected arguments from both sides as well as used critical thinking skills to formulate meaningful questions in real time. The students made integrative connections from computing to many other disciplines throughout the debates. They also learned to argue their point of view with someone who may be in disagreement.

Following the debates, I compiled the anonymous peer review comments from the non-debating students. I added up the numerical scores received on each of the five components. This was used to later help provide a holistic evaluation of a group's performance along with my own comments and those from their peers. As a teacher, I really enjoyed seeing how the debates energized their imaginations and helped prepare them well to think about writing a research paper related to many of the debate topics during the second half of the course.

2.4 Readings and Topics on Artificial Intelligence and Society

Following the midterm break of the course, students in my course were required to pick one of the eight topics below that would become the focus of a final research paper due at the end of the course.

1. Robots – their Rights & Roles in our Future; Place of Robots in Healthcare & Military
2. Dealing with Bias in Artificial Intelligence
3. Glass Cage: The Dangers of Too Much Automation
4. Technological Singularity: When Artificial Intelligence Exceeds Human Intellectual Capacity
5. Books & Newspapers of the Future; Will some be written by Robots (Robo-Journalism)?
6. The Ethical Challenges of Self-Driving Cars
7. Data Mining & Machine Learning for Recommendation Systems or Social Media
8. How Artificial Intelligence and Deep Learning Can Be Used to Evaluate and Create Art; Can Machines Recognize Beauty Itself?

As a class, we spent one day at the library learning more about creating an annotated bibliography with current sources from the last five years for their selected topic. Students practiced finding good journal articles using the academic databases our library had access to and gained more experience in different citation styles. Their annotated bibliography had to have at least four books, as well as four scholarly journal articles. It was good to get them away from always using Google, and searching for articles using academic databases specialized in computing research. Learning to dig, collect, and evaluate sources from different databases is a great skill to develop. By doing so, they also become "part archaeologist and part anthropologist" [12].

2.5 Implementing Writing Instruction and Peer Evaluation

There is no one way of writing well. By requiring students to do an annotated bibliography followed by a first draft of their research paper, you make writing more of a developmental process spread over time. They begin to see how writing is like a puzzle, and that writing and critical thinking go together. The annotated bibliography helps them generate and organize ideas gleaned from the sources they have gathered. Most importantly, it prevents them from procrastinating on their writing, and helps combat writing block. As Garvey indicates, "the writing process students go through is at least as important as the writing products that they eventually produce" [10].

My students were required to hand in their annotated bibliography two weeks before the first draft of the final research paper was due. Each source in their annotated bibliography included a short paragraph annotation, which evaluates the author, audience, relevance to their topic, quality of scholarship, and any connections to prior readings or research. I was able to quickly grade the annotated bibliographies using a rubric which simply checked off whether each of their annotations cited the source properly and included each of the five required components. The annotated bibliography prepared them for the actual writing of their paper, and moved them further along in formulating better quality research.

Like Garvey, I stressed that the final draft "will receive a lower grade (regardless of quality) if they do not hand in a serious effort for the first draft" [10]. After they completed their first draft, I randomly distributed these drafts to other students. Their classmates used a peer evaluation rubric to give them feedback in four areas: format, clarity of argument, use of evidence, and suggestions for improvement. Students appreciated the feedback on their work from their peers, and commented how much they learned from reading the writing of their peers. After returning and reading their peer reviews, I reminded them "expert writers do extensive rewriting" and of the motto to always "write once and edit twice" [2]. If time permits, doing a writing conference with the student on their first draft before they revise it can also be very beneficial.

By scaffolding the writing of the research paper into drafts, it gives students a chance to not only improve their writing, but also improve their grades. As Bean tells his students, "A C paper is an A paper turned in too soon" [2]. This helps them not be afraid of making mistakes, and take more risks in their writing. As students were revising their first draft, I encouraged them to read it aloud or to a friend. I also provided a few helpful *They Say / I Say* writing templates for strengthening their arguments. I wanted them to see a final draft

like an academic conversation with their audience [11].

Grading student writing can be incredibly taxing. To help save time grading their final drafts, I used a rubric broken down into these five categories.

1. Completed First Draft and Peer Review (30%)
2. Use of Evidence / Content from Sources (25%)
3. Organization of Paragraphs, Thesis, Clarity of Argument (25%)
4. Sentence Structure, Spelling, and Mechanics (10%)
5. Format and Documentation Style (10%)

Completing the first draft and peer review process was worth a lot and could be cursory checked off and scored when grading. For the other four categories, I provided an explanation of poor, fair, average, very good, and excellent along with the possible range of points that could be earned in each category. On average, it would take me about half an hour to read, score, and provide comments for a five to seven page paper using this rubric.

3 CONCLUSIONS AND FUTURE WORK

At the end of the course, students were asked four specific questions regarding the writing and debate components of the course. They could respond on a five-point scale from Strongly Disagree (1) up to Strongly Agree (5).

1. As a result of this course, I am better able to write for different purposes and audiences.
2. As a result of this course, I am better able to analyze sources/evidence.
3. As a result of this course, I am better able to use library resources.
4. The in-class debates helped me to improve my communication and critical thinking skills.

All four questions scored an average of at least 4.6 on the five-point scale with my class of 18 students from this past year. Being able to better use library resources scored the highest. Student comments mentioned how helpful the annotated bibliography assignment was in guiding and producing better writing. Their comments also showed they responded well to both debates and really enjoyed them. I highly recommend recording any in class debates to share with colleagues or to document and point out improvements students can make. By recording, you can also provide evidence of oral communication in the classroom for assessment or accreditation purposes.

Overall, the writing and speech instruction of this course gave students invaluable experience, which can benefit them greatly in their future careers. For

those that choose to go on to graduate school, it can boost their confidence for the writing and presenting of a thesis or dissertation. In addition, many of our students now have a GitHub account to display their coding projects. Writing samples would make a great addition here as well. These samples on a GitHub account can serve as a valuable *e-portfolio* for students upon graduation in addition to their resume.

For future research, it would be good to survey both graduating seniors and graduates from the last couple of years to see the long-term benefits of this writing and speech instruction in the major. I would also like to do an initial writing assessment at the start of the course, and compare it to an assessment of their writing in the final research paper. In addition, we hope to start doing more writing instruction in the discipline in courses that lend themselves to writing like Programming Languages, Theory of Computation, and Software Engineering.

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