Reading the Ellipses: Science Plays as Models for Inquiry Projects

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Prelude

Educators, from Socrates to John Dewey, have seen inquiry as the crux of education. Inquiry, derived from the natural curiosity of the learner, develops into an analysis of available sources. The inquirer is able to evaluate where he or she stands in juxtaposition to other voices on the topic. School-originated research projects surely stem from this desire to engage students in their own questions. In North Carolina, during their junior year of high school, students are expected to choose an individual topic to investigate, research it fully, and develop an six- to ten-page critical research paper fully exploring that topic through a variety of sources; implementation of the Charlotte-Mecklenburg Schools Graduation Project elevates this project from a useful learning experience to a graduation requirement in my school district. In fact, a research project is a potentially transformative experience for students, not to mention an activity that encourages them to engage in democratic citizenship as adults.

Despite the many positive aspects of research projects, they tend to get a bad reputation in schools, among both students and teachers. Perhaps this is due to the fact that some of us are mired in a view of research writing as stale, boring, and impersonal. Nothing is further from the truth. Research writing is often inventive, frequently playful, and occasionally downright poetic; for example, writers such as Brian Greene, Sarah Vowell, and Neil deGrasse Tyson challenge preconceptions about researched nonfiction. Another problem in teaching research writing is that students tend to feel that some topics are good "research topics" and other concepts just aren't feasible. This problem stems from the fact that most research instruction tends to be thesis- or hypothesis-driven; that is, students are told to figure out a position on some topic (that they may or may not know much about), then they research their side. Conversely, real world research is usually inquiry-driven; research begins with the researcher's curiosity.

In an effort to encourage students to engage in the research process and write with individuality (or voice), last spring I experimented with multigenre writing and mentor texts. Multigenre writing activities encourage students to consider their topics and possible audiences for what they have to say, then select genres in which to write that most fully engage that topic and that audience. Next, they might try out a different genre to explore some other facet of the subject. According to Tom Romano, "Genres of narrative thinking require writers to be concrete and precise. They can't just *tell* in abstract language. They can't just be paradigmatic. They must show. They must make their topics palpable. They must penetrate. And that is what multigenre papers enable

their authors to do."[1] For example, in my class we read articles both for and against the use of the internet in the classroom. Students wrote poems, conducted surveys and created graphs, drafted editorials, and composed science fiction, among other genres. The multigenre writing we did encouraged students to explore their research topics from a variety of angles and perspectives. Using mentor texts is another way teachers might envision the texts they teach. Instead of teaching texts from either transactional or aesthetic perspectives, a mentor text approach encourages students to examine published works with an eye for craft. We ask ourselves questions like how is the writer achieving her purpose and what elements of his style might we find useful to adopt? My students read mentor texts from writers like Greene, Vowell, and Tyson, whose writing is both informative and interesting. I found, however, that these exciting activities ultimately led to a dead end in terms of my students' research writing; when it came time to select topics and begin writing, students gravitated toward traditional "research topics," not the truly intriguing questions we had explored so avidly through journal writing, mentor texts, and multigenre pieces. So, as a teacher it is definitely useful to bring lively research writing into the classroom, but it doesn't resolve the other looming concern of moving students to inquiry-based research.

research writing: a play

Student: What does research writing look like? What do you want me to write?

Me: There isn't a formula. Think of a way to communicate what you've learned to an audience. How can you get other people to understand what you've come to understand?

Student: Hmm. Can I start with a dialogue?

Me: Everything does.

Meanwhile, good theater, like research writing, is often inquiry-driven by its nature. Playwrights explore the tensions of being a human being, whether those tensions stem from relationships, external forces, or one's own nature. The realm of science offers plenty of tensions for playwrights to explore and the kinds of questions that keep scientists, philosophers, and dramatists alike up at night: how did life on Earth begin? What is the relationship between humans and the environment? How do humans fit in with the rest of the universe?

When it comes to presentation, though, the boundaries of plays are much more abstract than the stringent requirements of the Modern Language Association or the traditional requirements of high school and college English teachers; even those boundaries that do exist are frequently ignored by playwrights (for example, the "fourth wall" between performers and audience is routinely ignored in postmodern theater). Perhaps this genre offers a world of possibility for teachers hoping to open students' minds to inquiry and for students willing to engage with their questions.

flailing: a meta-play

Playwright (reaching out blindly): Where's the edge? It should be around here somewhere… (He flails.)

Director (squinting speculatively): It is. It's really close to where you're standing.

Playwright (with frustration): Well, where is it?

Director: The thing is, if I were to tell you where it is, well, you'd know it's there.

Playwright (stopping): That's rather the point.

Director: No, I mean, it's only there when you know it's there. (Beat.) Hey, you haven't bumbled around stage left yet…

Playwright: Stage left! I wonder what's over there?...

The theory behind this curriculum unit is culled from Romano's work on multigenre writing, but also from Katie Wood Ray's work on the mentor text approach to teaching writing. In *Study Driven: A Framework for Planning Units of Study in the Writing Workshop*, she discusses the ways teachers can use mentor texts as ways to help students explore writing in active rather than passive ways. She argues for a reconfiguration of the way we use the word "curriculum": "Framing instruction as study represents an essential stance to teaching and learning, an *inquiry stance*, characterized by repositioning curriculum as the outcome of instruction rather than the starting point."[2] By studying texts first, then asking student to identify important elements and experiment with those elements in their own work, any type of writing instruction will be student-centered, with students invested in the process.

Contextualizing the Unit

I teach eleventh grade English courses of all levels, including Standard, Inclusion, Honors, Advanced Placement, and International Baccalaureate, and believe that all students should have interesting, challenging reading and work assigned to them. This curriculum unit is intended for any type of English student; I provide many ways to differentiate depending on the class. It is highly appropriate as a way into teaching research and research writing.

I have selected Michael Frayn's *Copenhagen* to study in particular because the sources he used are available, as is his comment on the relationship between research and his writing. Instead of teaching a particular form for research writing, these texts will operate as mentor texts, or examples, as my students begin their own process of research and writing. My instruction will focus on identifying the pivotal questions the plays are

exploring. Class activities will also be geared toward helping students see the research underlying the plays. In my classroom I will begin with Frayn's *Copenhagen* because it offers a thorough analysis of sources in the postscript, which makes transparent Frayn's research process. In his postscript, Frayn carefully evaluates historians, their biases, and his own perspective as a playwright and reader of both science and history texts. This curriculum unit will focus on the study of Frayn's work, then the transition into students' inquiry projects.

The next step of the curriculum unit will involve students researching and writing their own plays on science and history topics. Using any plays we study together as mentor texts, students will contemplate the tensions and missing spaces in science and history and choose a question on which to focus their research projects. They will then gather both qualitative and quantitative evidence relating to their questions. Students will write one-act plays dramatizing these tensions or ellipses followed by postscripts detailing their sources and the students' understandings of those sources. (Frayn's postscript would be a highly appropriate mentor text for this piece of writing.) For example, I might write a play detailing the struggles faced by astronomer Alan Stern (or a character based on him), a vocal opponent of the definition of "planet" that excludes Pluto from this classification. My postscript might analyze my understanding of Stern's interviews and blogs, the transcripts and articles written about the International Astronomical Union's crucial vote, and *The Pluto Files*, Neil deGrasse Tyson's account of Pluto's demotion.

Students will also be encouraged to stage some of the plays they write. The process of actually staging the plays may well be as crucial as the other phases; students will need to determine how their texts interact with an audience. How can they make their points and conclusions clear? Are there technical or jargon-related questions that will impede audience understanding? These are the questions they would face in any formal presentation of their research.

At this juncture students will be able to adapt their plays and postscripts into formal research papers, if this is necessary for school, state, or course requirements. If they choose, they may adopt more formal "research paper" language, and they will certainly need to incorporate MLA or APA standards. For the CMS Graduation Project specifically, the plays and postscripts can be adapted for the essay component of the project; the rubric is open enough to allow genre shifting, as long as sources are incorporated. Performances of the plays prepare students for the formal presentation of their work for a review board; they will have already dealt with vocabulary and other issues that come with communicating complex concepts to a general audience. Since they have already embarked on research processes with these topics and come to personal understandings, if not any actual answers, my hope is that their sense of ownership and engagement in the topics will see them through the rest of the requisite, formal research writing.

convergences: an allegorical play

Science: I am the complex, esoteric underpinnings of you and your world. Fear me!

Humanity (cocking his head): Uh, yeah. You are also the simple, mundane understanding that makes ice, first aid, and Kool Aid.

Science (haughtily): You focus on simplicity because the complex defies you!

Humanity (coolly): Listen, babe, it's my understanding of you that formulates your existence in the first place. (Pats Science's shoulder.)

Philosophy: Fo' shizzle!

Act I: The Play's the Thing

This part of the unit will be about interpreting and responding to Frayn's *Copenhagen* in ways that will allow the play to act as a mentor text when students begin researching and writing their own plays.

Pre-Reading

Students should first engage in some pre-reading thinking and research. I begin this unit by posting the names of Bohr and Heisenberg on the board or a large piece of chart paper. After students list everything they know about these two men, I challenge students to find out more about them; students could interview their science instructors, do a Google search, or comb library books and/or science and history textbooks for further information. I leave the brainstorming chart paper up on the board or the wall for several days, allowing students to add to it as their research continues.

If the topic does not come up naturally as a product of the students' research, I will want to introduce the topic of the atomic bomb prior to reading *Copenhagen*. This discussion should be contextualized with the frame of World War II. Depending on how much time I decide to spend on this component, students could work in groups to research and present findings on various aspects of and names associated with the atomic bomb projects in the United States and Germany, the causes and outcomes of World War II, the Holocaust, and perhaps the science of atomic bombs. Additionally, students should be aware of Heisenberg's Uncertainty Principle before reading the play; this offers me the opportunity to invite a guest scientist or science teacher to engage in Q&A with the students.

Reading

Students should read the entire text of *Copenhagen*. These are a few of the options available:

Option #1: Assign the play as independent reading. As they read, students should keep a double entry journal. On the left side, they can list quotes, questions, and details. The right side can be filled in later.

Option #2: Read the play together as a class. I might have three students volunteer to read the three parts. Students should still maintain the left side of a double-entry reading while reading.

Option #3: Hybridize options 1 and 2. For example, I often have students read a good chunk from the beginning of the play out loud, engage in some whole-class discussion about the characters and staging, and then assign the rest of the play for outside reading. Student still keep the left side of a double entry journal.

I almost always lean toward the hybrid option, although in my Advanced Placement classes, I will do more assigned independent reading, while my Standard and Inclusion classes might use more in-class reading activities.

The reading journals are an important tool for this unit for many reasons. For one thing, it is a strategy to help students rethink notes and note-taking. The double-entry columns allow students to differentiate quotes and summaries from their own thinking about the texts. Later, when they begin their own research, students will have this strategy in their toolbox as way to take notes from texts and keep track of their own thinking.

Post-reading

After reading the play, students should engage in three types of activities: discussion, writing, and performance. Activities should also be divided among small group, whole class, and individual in type. I will make a variety of suggestions that cross and include all of these categories, but you should avoid the temptation to do it all. Rather, considering the needs of your students, choose the activities that will best serve them and your goals in teaching the class.

Heisenberg on Trial: In this activity, the class will prepare and stage their own version of Werner Heisenberg's trial based on information from the play and from any research the students may do or have done. One way to do this is by dividing the class into three groups: prosecution, defense, and neutral. The prosecution group will handle the prosecution's arguments, questions, and witnesses sympathetic to the prosecution. The defense group will handle the defense's arguments, questions, and witnesses sympathetic to the defense. The neutral group will handle any witnesses who are difficult to determine, ambivalent, or objective; this group will also evaluate the arguments of the

other two sides. I usually allow students to choose their groups, unless they are overwhelmingly unbalanced. Group assignment could be random just as easily. I also usually require students to write up some thoughts after the activity; if they are portraying a particular person, they may write from that person's perspective or they may judge the results of the trial. This activity then encompasses writing and prepared performance; it also has room for extemporaneous discussion, such as between prosecution and defense teams and witnesses and among the neutral team or jury afterward. This activity is a good transition into a discussion of Frayn's portrayal of Heisenberg in the play. Does Frayn portray as a hero, a villain, or a morally ambivalent figure? These questions are critical to the teacher attempting to make transparent Frayn's movement from comprehension of historical sources to evaluation of these sources to synthesis of the sources into Frayn's personal perspective.

Reading Journals: While reading, students kept the left column of a response journal. They should use the right column to record their analysis of the left column; they might answer their own questions or make connections to other works, their lives or other issues. One possibly for extending this assignment is a dialectic response. After students complete the first two columns, they exchange responses. A partner then writes her own thoughts on what the original writer has pondered in columns one and two, which the original writer reflects on in a fourth column.

Exponential Discussion: One way of getting everyone involved in a whole-class discussion is by building up to it. First, have students ponder a discussion question informally in their own notebooks (see appendix for list of discussion questions). Then each student may pair up with another student and share. From this point, move into a whole class discussion. To encourage diffident or self-conscious students to speak up, the teacher might have students participate by bringing up good ideas their partners shared. (You may wish to make this endpoint apparent to students to avoid feelings of betrayal later.)

Staging a Scene: Perhaps the most effective way to understand a script and what should or should not be a part of one is through staging a scene. This activity may take as much or as little time in time as the teacher is willing to devote to it. On the minimalist side, you may have small groups of students (two to three students in each group) select a page or two of the play to stage in class. On a grander scale, you might allow the small groups to plan extensive productions, either for the stage or the screen. In either case, a pair of mini-lessons on subtext and blocking will be appropriate. For example, when I began teaching *Copenhagen*, I briefly explained subtext as the meaning characters are trying to relay verbally and nonverbally in a play. We then read the first four pages of the play out loud. Students then broke up into groups of three and selected eight lines of text to block. I required them to have some sort of movement with every line (the movement did not have to be the person speaking). See the appendix for a list of suggested scenes for staging from *Copenhagen*.

Act II: Going to the Source

Frayn's postscript to *Copenhagen* outlines his process of reading and analyzing historical documents related to Bohr and Heisenberg; he also documents the response of others to his play and records the way his play interacts with history. In this section of the unit, students will read and analyze the postscript, also examining some of the historical documents to which Frayn refers.

Students should skim and pre-read the postscript individually. This might be a homework assignment or an in-class activity in which students glance at the text in search of keywords. After the pre-reading, students can pose keywords or phrases for discussion. It might be worthwhile to keep track of their ideas on chart paper that stays up on the wall throughout this study.

Students should next work in groups to specifically study "chunks" of the postscript. The groups do not need to cover the postscript in its entirety. You can decide which sections are most relevant for study. I simply divided the postscript according to Frayn's natural breaks. In groups, students should "map" Frayn's progress in their section. They should represent visually Frayn's analysis of the historical documents and how his analysis relates to *Copenhagen*. They should also refer to the important terms or people mentioned in their passage and pull our significant quotes.

After sharing and discussion of the text maps, the teacher should provide several examples of the sources Frayn explores in his postscript. The teacher should be sure that the sources she uses were covered in the sections from the postscript analyzed by the student groups. I recommend in particular an excerpt from the Farm Hall transcripts, which are conversations between Heisenberg and other German physicists held in Britain during and after World War II; these transcripts were annotate and published by Jeremy Bernstein as *Hitler's Uranium Club*. The resources section at the end of this unit recommends a few other such sources you might find useful. Working in pairs, students should annotate one or more of the source texts by highlighting or underlining parts of the texts that relate to the play or the postscript; they should also note questions and topics for discussion. The teacher should next facilitate a whole group discussion of these sources, the students' understandings of them, and Frayn's understandings of them; in some cases it may be useful for students to move into small groups to work through questions and ideas broached with their partners before moving into a whole group conversation.

Act III: From Curiosity to Inquiry

As in Shakespearean theater, Act III is the crux of the unit. It is also the most challenging moment for both teachers and students. Until this point, teachers and students have been treading on difficult but well-traveled ground: response to literature. Now, you must help the students move forward in developing their own points of inquiry.

Paulo Freire discusses in *The Pedagogy of Freedom: Ethics, Democracy, and Civic Courage* the difference between natural curiosity and inquiry:

> In truth, ingenuous, 'unarmed' curiosity, which is associated with common sense knowledge, is the same curiosity that, as it develops its critical possibilities through a more rigorous methodological approximation of the known object, becomes epistemological curiosity. It changes in quality but not in essence… Curiosity as restless questioning, as movement toward the revelation of something hidden, as a question verbalized or not, as search for clarity, as a moment of attention, suggestion, and vigilance, constitutes an integral part of the phenomenon of being alive. There could be no creativity without the curiosity that moves us and sets us patiently before a world that we did not make, to add to it something of our own making.[3]

All human beings have (or suffer from, as the case may be) from natural curiosity. The trick for teachers is morphing that innate "restless questioning" into "more rigorous methodological approximation."[4] Analysis of Frayn's *Copenhagen* and his postscript in particular helps set us on that path to epistemological curiosity by surfacing the process of research and its possibilities for application. The next step in the classroom is inundation of ideas.

The teacher should now engage in activities to help students identify ellipses in history and science, a very difficult prospect since ellipses are primarily identified by their absence; examples of such ellipses include ambiguity (as evinced by *Copenhagen*), perspectives of people or groups often ignored (as in Toni Morrison's *Beloved*), and issues with multiple perspectives (such as the demotion of Pluto, which Tyson explicates in *The Pluto Files*). Science and history are not the only academic fields appropriate to this sort of analysis; they do have the benefit of being core subjects studied by all students in public high schools, however.

The route to inquiry is paved by questions. For example:

- A student may brainstorm lists of scientific or historical concepts in which they are interested.

- The student may then select one idea from this list and recall all of the names, places, things, and events associated with that idea.

- The student may then brainstorm questions: who is this person? What happened when ___was discovered? How did this discovery impact the discoverer's life? Who or what influenced this person's life? Etc.

- The process may begin again if no points of curiosity pan out the first time.

This process is challenging for students because they must come up with their own areas of curiosity, something that neither teachers, parents, or peers can do for them. This process is challenging for teachers because engaging in this process with multiple students simultaneously will be difficult; each student will approach brainstorming a different way. Plus, eventually, they will all be investigating different topics. *This is okay*.

Another strategy teachers may use at this juncture is providing reading material on a variety of scientific and historical topics. Science magazines like *Wired* and *Scientific American*, history magazines like *History Today*, or *Smithsonian* (which does it all) offer articles on a variety of topics that may interest students.

At any rate, the goal of this act is to have each student engaged in a personal inquiry.

Act IV: Researching and Writing Socially

As students begin research, the primary responsibility of the teacher will be to find resources. Students will not be the savvy research consumers that teachers presumably are; helping students to find interesting books and articles on their topics and encouraging students to evaluate the perspectives of the research they are reading are the foci of this period.

Once students begin to read texts relating to their inquiries, teachers can provide a few classroom structures that help students understand and interact with the research.

- Response notebooks: You might encourage students to keep a double-entry log consisting of questions, quotations and paraphrased facts on one side and responses or analysis on the other.

- Inquiry groups: You might help students form groups of peers with whom the texts and questions can be discussed.

- Process logs: Students might keep track of their thoughts on their inquiry on a daily or weekly basis. In my classroom, we accomplish this through blogging. We have a class website with a blog function; as students begin their research process and starting reading, they write blog posts about twice a week updating their thoughts and questions. Using the blog format also allows more

opportunities for students to interact with each other and engage in discourse on their topics.

At some point students will need to begin writing their plays. Writers all operate differently. Some writers will begin writing from the moment they get the idea for the play, using research to fill in the gaps as they go. Others will write intermittently as they read and research. Others still will want to wait until they've read everything they can, then finally begin writing. In a classroom setting, the last group offers a few potential opportunities for the teacher to intervene. For one thing, no one has ever read everything they need to know to begin writing about a topic. So at some point the teacher may need to say that a few pages are due to encourage the completionists to get started on the writing.

The beauty of writing plays is that they necessitate specific writing. Students must think carefully about the characters' actions and speech in order to create the drama. Romano offers this advice: "Resist explaining, summing up, and analyzing. Create scenes instead. Become like the novelist or filmmaker. Dramatize without interpretation."[5] Of course, interpretation will happen. It is unavoidable. But play-writing offers an opportunity for student writers to think an idea through via characters and dialogue, rather than through expository writing, which is often a less natural mode for young writers.

Writing their postscripts will give students the opportunity to discuss possible interpretations of their scenes and to analyze the ways in which their sources impacted them in the writing. They can discuss the ways in which they reached conclusions about characters' behaviors or thoughts. Plus, they accomplish all of this meaningful writing and thought in the context of writing about themselves writing a play. The intricacies of assuming a faux objective academic voice are averted. Rather than developing an idea of history or science's neutrality, students can see the ways that conflicting and merging voices intersect to form history. Students can also see the significance of choices in writing, history, and science: what should be included and what should be left out?

Act V: Everybody dies

Classical tragedies often conclude with the main characters and usually a few others hitting the stage floor in gouts of blood. To follow suit, you may wish to have students revise their plays and postscripts into traditional research papers. It will be only a matter of tweaking the postscript with its analysis of sources and conclusions reached into expository writing and teaching MLA or APA guidelines for source documentation. For those whose schools or districts mandate this type of research writing, this is a possibility, although I might point out that the writing of the play and postscript already develops all of the necessary critical thinking, source synthesis, and claim assertion skills we hope to develop through research writing. Teacher and research Cynthia Urbanski argues that we should be aware of how we juxtapose "academic" writing, such as a traditional research

paper with “other” writing; without care on our parts, we may privilege research papers over plays.[6]

The alternate perspective is that helping students develop their plays and postscripts into traditional research papers helps them to conceptualize audiences for writing. Certainly, this is an awareness needed for academic success. The question that is left in my mind is whether we need to teach students to conform to academic norms; I suspect that there are pressures aplenty to teach them this skill. On the other hand, far fewer assignments seem geared toward alternate audiences and purposes.

There is another endpoint for this drama and that is, of course, in the dramatization of student plays. You may wish to allow classes or groups to select a few of the plays to perform. Or classes might plan to showcase all of the plays in short vignettes. The options will vary from class to class and teacher to teacher.

Postscript

My curriculum unit focuses on a science play as a mentor text for research writing. If you wanted to try a similar structure but with a less scientific angle, you might consider teaching Toni Morrison’s Pulitzer Prize-winning novel, *Beloved*. This novel narrates the story of a group of former slaves and the psychological effect of slavery on their lives; the focus of the novel is the protagonist’s choice to kill her own children rather than have them returned to slavery. Like *Copenhagen*, *Beloved* offers a controversial character in Sethe, and the novel reveals multiple layers to the ethical dilemma. In addition to the many historical sources available about American slavery, abolition, and Margaret Garner, the real-life escaped slave woman on whom Morrison’s novel is based, and literary sources, like slave narratives, Morrison has talked extensively about the research and writing process she went through in writing *Beloved*; many interviews with Morrison are compiled in *Conversations with Toni Morrison,* edited by Danille Taylor-Guthrie. There is also an opera based on *Beloved* that offers an alternative artistic perspective on the narrative.

I actually taught this curriculum unit based on *Copenhagen* and followed it up by studying *Beloved*, using many of the resources and ideas mentioned above. In many ways, though, I wish that I had introduced *Beloved* first; one problem with *Copenhagen* is that it does not critique science as a predominantly white male institution. In *Beloved*, on the other hand, Morrison critiques the traditionally white male perspective of history and speaks back to historians as well as to genres like slave narratives. I think that it might be valuable to students to read *Copenhagen* with a critical eye, something more likely to happen after an in-depth discussion of *Beloved* and the way Morrison uses the novel to enter a discourse with history, foregrounding issues of race and gender.

As you evaluate other possible works for a similar unit, consider the availability of the author's sources and any records of the author's thoughts about process and analysis of sources.

Pedagogical Resources

Brannon, Lil, Sally Griffin, Karen Haag, Tony Iannone, Cynthia Urbanski, and Shana Woodward. *Thinking Out Loud on Paper: The Student Daybook as a Tool to Foster Learning.* Portsmouth: Heinemann, 2008. This book is a fantastic resource for teachers interested in using writers' notebooks, or daybooks, in their classrooms. In addition to giving practical, day-to-day ideas for implementing daybooks in kindergarten through college-level classrooms, the authors think through the philosophy behind such a classroom practice.

Freire, Paulo. *Pedagogy of Freedom: Ethics, Democracy, and Civic Courage.* Lanham: Rowman & Littlefield Publishers, 1998. This book is more philosophical than practical, yet it underscores the need for teachers to know *why* they are teaching what they are teaching.

Gallagher, Chris W. and Amy Lee. *Teaching Writing That Matters: Tools and Projects That Motivate Adolescent Writers.* New York: Scholastic, 2008. Gallagher and Lee provide a toolbox of useful ideas for teaching writing in general; specifically, there is a very useful section on research writing.

Holland, Dorothy, Debra Skinner, William Lachicotte Jr., and Carole Cain. *Identity and Agency in Cultural Worlds.* Cambridge: Harvard University Press, 1998. This text is a way of understanding schooling and what is happening socially in schools. It is not intended for teachers specifically, but it does provide an intriguing lens through which we might view our practice.

Ray, Katie Wood. Study Driven: *A Framework for Planning Units of Study in the Writing Workshop*. Portsmouth: Heinemann, 2006. An excellent, practical resource for classroom teachers, this book outlines the concept of mentor texts and provides many examples of possible units. This book can help teachers conceptualize using mentor texts in their classrooms, whether they are elementary or high school teachers.

Romano, Tom. *Blending Genre, Altering Style: Writing Multigenre Papers.* Portsmouth: Boynton/Cook Publishers, 2000. Romano is a proponent of multi-genre writing, in which writers experiment with form and consider how form and meaning connect.

Literary Resources

Frayn, Michael. *Copenhagen.* New York: Random House, 1998.

Morrison, Toni. *Beloved*. New York: Knopf, 1987. I referred to Morrison's novel as another possibility for a literary study leading into an analysis of sources.

Taylor-Guthrie, Danille, ed. *Conversations with Toni Morrison*. Jackson: University of Mississippi Press, 1994. For teachers interested in substituting *Beloved* for *Copenhagen* in this curriculum unit, this book offers more than twenty interviews with Morrison, many of which refer to *Beloved* and her process in writing it.

Historical Resources

Bernstein, Jeremy. *Hitler's Uranium Club: The Secret Recordings at Farm Hall.* New York: Copernicus Books, 2001. This is the actual transcript of the Farm Hall recordings, made when the captured German physicists were secretly held in Britain during and after World War II. It has been usefully annotated by Bernstein, a physicist who translates the math and science content for a general audience. I recommend excerpting the section when the German physicists intially discover that the Americans have dropped the atomic bomb on Hiroshima.

Bohr, Niels. *The Philosophical Writings of Niels Bohr*. Connecticut: Oxbow Press, 1987. I did not use excerpts from this work, but for teachers interested in fleshing out the historical persona of Niels Bohr or for those interested in developing the science themes more deeply, this book might prove useful.

Heisenberg, Werner. *Physics and Beyond*. Harper and Row: 1971. This book is Heisenberg's memoirs. This might be useful, depending on how much time you opt to spend on this study. Also, if you are including a memoir study at some other point in your class, excerpts from this book might provide a nice tie-in.

Powers, Thomas. *Heisenberg's War: The Secret History of the German Bomb.* De Capo Press, 1993. Powers is sympathetic to Heisenberg and presents this argument for his heroization. Frayn drew from this source extensively. Worth excerpting is the chapter about the meeting between Heisenberg and Bohr in 1941.

Rose, Paul Lawrence. *Heisenberg and the Nazi Atomic Bomb Project*. University of California Press, 1998. Rose is Powers' polar opposite, and his tone is easily read as spiteful toward Heisenberg. It provides an intriguing contrast to Powers' work.

Science Resources

Greene Brian. *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory*. New York: Vintage Books, 1999. While not necessary for teaching this unit, teachers who are interested in further understanding physics should check out this book, which is compellingly written and well-explained.

Lindley, David. *Uncertainty: Einstein, Heisenberg, Bohr, and the Struggle for the Soul of Science.* Anchor, 2008. Another book that is completely extra credit, Lindley does provide additional perspective about quantum physics, the scientists who are mentioned in *Copenhagen*, and particularly the Uncertainty Principle.

Appendix I- Discussion Questions for Encouraging Conversations about *Copenhagen*

What is Margrethe's significance in the play?

Why are Bohr and Margrethe's children referred to with such frequency?

How are science and scientists portrayed in this play?

How does the play portray Heisenberg?

What is the relationship between the Uncertainty Principle and Heisenberg's personal life in the play?

Based on your reading of the postscript and other sources, what is your view of Heisenberg's intentions?

Why does the play revise the essential conversation between Heisenberg and Bohr so many times?

Why does the play include so much of the specific science and math related to atomic bomb creation?

What do you presume about the intended audience of *Copenhagen*?

How do you feel about Frayn's decision to leave out historical information about the cyclotron (as he discusses in the postscript)? What other events or ideas does Frayn leave out, and do you think he made the right choices? Why?

Appendix II- Scenes You Might Consider Staging from *Copenhagen*

Some of these scenes are much longer than others, and you may wish to break them up further or invite students to edit or select appropriate breaks. The pages numbers are from the Anchor Books version of the play.

The first scene- pages 1-6

The skiing metaphor- pages 24-25

The first version of the meeting- pages 32-45

The second version of the meeting- pages 77-86

The third version of the meeting- pages 88-92

Heisenberg's monologue about traveling through Germany during WWII- 92-93

Final scene- pages 93-94

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[1]Tom Romano, *Blending Genre, Altering Style: Writing Multigenre Papers* (Portsmouth: Boynton/Cook Publishers, 2000), 56.

[2]Katie Wood Ray, *Study Driven: A Framework for Planning Units of Study in the Writing Workshop* (Portsmouth: Heinemann, 2006), 19.

[3]Paulo Freire, *Pedagogy of Freedom: Ethics, Democracy, and Civic Courage* (Lanham: Rowman & Littlefield Publishers, 1998), 37-38.

[4]Paulo Freire, *Pedagogy of Freedom: Ethics, Democracy, and Civic Courage* (Lanham: Rowman & Littlefield Publishers, 1998), 37-38.

[5]Tom Romano, *Blending Genre, Altering Style: Writing Multigenre Papers* (Portsmouth: Boynton/Cook Publishers, 2000), 72.

[6]Cynthia Urbanski, Unpublished article (2009).