

WRITING ARGUMENTS WITH EVIDENCE: THE CLAIM-EVIDENCE-
REASONING FRAMEWORK AND SCIENTIFIC LITERACY

by

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ABSTRACT

Tenth-grade students were struggling to meet proficiency levels in argumentative writing activities and often made claims in science discussions without using evidence and reason to support them. Over one school year, tenth-grade biology students were introduced to various strategies to address this problem. Close Reading annotations, Claim-Evidence-Reasoning (CER) frameworks and bell-ringer journaling were used within two treatment units: one on ecology and one on microbiology. Student journal answers and lab discussions were assessed for the use of evidence and reasoning to support arguments and students were given a pre-, mid-, and post-treatment writing assessment to measure improvement. Results indicate that students improved in their use of evidence and reasoning to support claims in journal writing and lab discussions and about half of the students showed growth on their argumentative writing assessment. Students who did not complete the practices or participate fully did not show improvement.

INTRODUCTION AND BACKGROUND

This research project was completed at Helena High School (HHS) in Helena, Montana, the capital city of a large, sparsely populated, largely agricultural state. Helena has a population of about 30,000 people, but the school district also serves a number of neighboring towns. The greater Helena area has a population estimated around 70,000 and is described by U.S. News & World Report in their 2018 assessment of the nation's public schools as a "remote town." The residents are mostly Caucasian (93%) with small populations of American Indians (3%) and Hispanic or Latino persons (3%). Median income in 2016 was \$52,288 and the town had a poverty rate of 16.7% (United States Census Bureau, 2016).

School Demographics

Helena High had a student population of about 1,600 kids in grades nine through twelve with a student-teacher ratio of 15:1. Our free and reduced lunch population was about 20%, but an estimated 40% of students in the 2017-18 school year qualified for the service (Thennis, 2017). Most of the students live in an urban/suburban setting, but many live in more rural surrounding areas and travel to Helena for school. The students are mostly white Caucasians (>87%) with a low percentage (<13%) Native Americans, African Americans, Hispanic/Latino and other ethnicities (U.S. News & World Report, 2018).

This intervention was implemented in two sections of Biology I. Biology I is not technically a required course, but most sophomores take it as the second of their two required science credits after completing Earth Science in the ninth grade. The other

option for this course is Advanced Placement (AP) Biology, which requires students to take Chemistry concurrently, which removes about 60 of the more academically focused science students from our pool in regular Biology I.

The students were a mix of high-achieving and average kids, upperclassmen who were re-taking the course, and students with special needs. Of the 54 students who participated in this investigation, thirteen (24%) had Individualized Education Plans (IEP's) or 504 accommodations. Two students had special needs specific enough to have a dedicated paraprofessional, one was legally blind and one student from the Ukraine was in the process of learning English as a third language. There were about 23 students in the first period of the day (8:20 AM to 9:10 AM) and 27 students in the second period (9:15 AM-10:05 AM) with some fluctuation occurring throughout the 187-day school year. Classes ran 45 minutes on Mondays and 50 minutes on Tuesday-Friday.

I have been teaching science at Helena High for eleven years. Currently I teach Biology I and Project Lead the Way principles of biomedical sciences. The second course is part of a national program to increase medical vocational classes at the high school level and required a license in Career and Technical Education which I gained in 2013 after a two-week intensive training at Washington State University in Spokane, Washington. I also hold undergraduate degrees in biology and general science education from Montana State University in Bozeman, Montana, and a degree in biological sciences with an environmental science minor from Willamette University in Salem, Oregon. At Helena High I have taught a variety of courses including earth science, honors biology and environmental studies. In my free time, I coach our Science Olympiad and

Envirothon teams and have helped prepare students to compete at state- and national-level events.

Research Questions

The purpose of this investigation was to improve student use of data-based evidence to support their claims about science topics. I hypothesized that one way to get students to alter their beliefs would be to practice researching and writing about science topics in an argumentative format similar to the College Board's American College Test (ACT) writing assessment. This system would allow students to practice their writing and literacy skills while improving their understanding of science content. In the Helena School District, students take the ACT for free as Juniors and are also given a writing assessment each fall and spring similar to the ACT which is used to measure proficiency and growth in writing and critical thinking skills. This assessment is referred to as the District Writing Assessment (DWA).

For this action research project, students were given the Claim-Evidence-Reasoning (CER) frameworks based on the model described by McNeill and Krajcik (2011) when writing lab discussions and conclusions and answering "bell ringer" questions at the beginning of class. We also used close reading strategies, pre-writing worksheets and an ACT-format practice essay. These treatments applied the concept of using evidence to support arguments in different settings and formats in hopes of improving student achievement on the DWA and ACT.

This project was meaningful to me because claims about scientific topics are often used in popular culture improperly without evidence or reasoning to support them. This

leads to misconceptions and misunderstandings that can be confusing or even dangerous and it is difficult to get children to change their understanding even with inquiry labs and data alone. My overall goal was to see if argumentative writing could lead students to a new understanding of complex concepts that would create lasting conceptual change and improve their ability to apply these skills and concepts in various settings. The primary question investigated was “How does the use of evidence-based argumentation in science class impact students’ scores on ACT-like writing assessments?” My sub questions were:

1. Will the use of Claim-Evidence-Reasoning (CER) models increase the frequency of evidence used to support conclusions in lab write-ups?
2. Will the use of close reading strategies and argumentative writing lead to deeper understanding of complex science topics?

CONCEPTUAL FRAMEWORK

This section will explain the background research on evidence-based argumentation and the struggles observed in many science classrooms on the topic. It will also review previous research on argumentative writing and define the interventions used in my classroom.

The ability of high school students to research a topic, think critically about sources and compose an opinion or argument from the information gained is becoming increasingly important in a world of easily accessible, but often low-quality information sources. Most standardized assessments of student achievement now include a written portion, such as the American College Test (ACT), which asks students to analyze and evaluate three given perspectives, “state and develop a perspective on the issue, and

explain the relationship between that perspective and those given” (American College Testing, 2017). This writing format is elegant because it requires information synthesis at the highest level. Not only do students need to understand the topic and process the perspectives given, but they also must form an opinion of their own and support it with evidence. As I graded our District Writing Assessment last fall and saw very few students who were writing with this level of finesse, I began to wonder whether we properly prepare students for this type of thinking and writing, and if not, then how to improve.

At the beginning of the school year, I gathered data on our student achievement on the ACT and DWA and found that only about 30% of my students were able to compose an argument using evidence and reasoning in the format required for the ACT. They are expected to reach proficiency by spring of their junior year, but as science teachers, we were not doing anything specific in our classes to help them. As part of the Next Generation Science Standards (NGSS), we are committed to helping students engage in argument from evidence and construct explanations (2013). We do ask students to use evidence in many of our classroom activities, but the practice does not seem to be transferring to other disciplines. This led me to begin researching what other educators have done to improve argumentation from evidence in their classes.

Argumentative Writing

Thomas McCann in “Research in the Teaching of English,” recognized the problems inherent in argumentative writing in his 1989 study of the writing abilities of 95 students in grades six, nine and twelve. Although the ninth graders were more able to

recognize and respond to opposing arguments than sixth graders, all levels showed a significant lack of data or factual support for their warrants (McCann, 1989). This is still a problem in instruction that needs to be addressed in our classrooms today.

Many researchers have analyzed teaching strategies on argumentative writing and their efficacy to help students tackle organization and message. Sampson and Grooms (2009) designed an investigation of “melting ice blocks” to increase the use of data-based evidence in classrooms. Students given a block of aluminum and a block of plastic developed arguments based on the comparative melting rates of ice cubes placed on the blocks over time. By the end of the investigation, students were able to “evaluate phenomena for their characteristics and compose research questions.” They also learned to collect data to use as evidence for a conclusion and communicate their findings to their classmates, which are skills that can be developed into general critical thinking about writing and evaluating sources (Sampson and Grooms, 2009).

Feretti, Lewis and Andrews-Weckerly (2009) took this research further by evaluating the use of sub-goals in increasing writing quality. In a study of 95 students, they found that the students were able to craft more effective arguments if the process was broken down into sub-goals to tackle one at a time, but that students in sixth and ninth grade still had not mastered the ability to develop complex arguments beyond a simple description of cause and effect. When a controversial topic was addressed (Arvola, 2012), students were less likely to use scientific data or evidence to strengthen their arguments and instead fell back on cultural values. This was true in many cultures when the students were asked to argue for or against a point of view that contradicted

their own (Dornbrak, 2014; Ozturk 2015). In these cases, the students' writing did not reflect their competency because they are only accessing their previously held cultural knowledge. However, if students are helped to understand the difference between their academic and cultural knowledge, evidence could be used to effectively support an argument in either case.

The consensus in the literature shows that proper teacher training will be essential in helping students develop these complex argumentative skills. Karisan and Topku (2016) found that pre-service teachers were not being given enough training in argumentative writing to be comfortable with it themselves and the practices were not translating to the classroom setting. McNeill, Katsh-Singer, González-Howard and Loper (2016) found four major themes in the impediments to teaching argumentative writing when they interviewed pre-service teachers: they all understood the importance of the skill, they all felt somewhat comfortable with teaching argumentative writing, they saw their students as capable of doing it, but they saw a lack of alignment with their subjects. This caused many of the teachers not to use argumentative writing prompts in their classrooms, even though the majority of teachers interviewed saw the value in doing so.

As a science teacher, I had very little training in teaching about writing or reading. I enjoy reading and writing, but really have no background in how to teach these skills. In 2017 I volunteered as a reader for our District Writing Assessment in order to learn more about the argumentative essay format and how it is being used by the ACT to assess critical thinking in students.

District Writing Assessment

The District Writing Assessment (DWA) is given to all students in the fall and spring each year to help get a picture of writing and critical thinking abilities in our students. It is written in the same format as the ACT writing portion which should give students extra practice before they are expected to write at a proficient level in the spring of their junior year. I chose this as the main assessment tool to measure student improvement because data were already available from the 2016-17 school year and could be compared to any changes observed during the 2017-18 school year. Also, data were available for the entire sophomore class as a control group to which I could compare my treatment groups. Lastly, the DWA is written and designed by a committee of assessment experts and provides a prediction of how the students will do on their ACT writing assessment. I designed an additional in-class essay assignment in the same format to see if there was any difference in student ability when given more time for reading and understanding the prompt and gathering background research on the topic before writing the essay.

Close Reading Strategy

The Close Reading format designed by our district librarians was the first Classroom Assessment Technique (CAT) I used to see how students were tackling difficult science topics when reading. I hypothesized that the DWA and ACT writing prompts may be overwhelming for students to decode, which may account for the low levels of proficiency. If students can't read and understand the question, how can they write a coherent evidence-based argument about the topic?

As defined by the Common Core Standards, close reading is “thoughtful, critical analysis of a text that focuses on significant details or patterns in order to develop a deep, precise understanding of the text’s form, craft, and meaning.” Different formats include deliberate re-reading of passages, using a pencil to annotate, discussing the passages with classmates or teachers and responding to text-dependent questions (Common Core, 2017).

Each year, thousands of students around the world participate in reading intervention programs. Some of these interventions are very expensive, and some show limited effectiveness. A 2014 study published in the *Journal of Adolescent & Adult Literacy* reviewed the work of 75 students in grades 7-8 to test the efficacy of the close reading strategy in an after-school setting (Fisher and Frey). Outcomes were compared with 247 students who received a traditional intervention. Results suggested that close reading can be an effective intervention, with “significant increases in student attendance, self-perception, and achievement” (Fisher and Frey, 2014). At the end of the treatment, students were given their grade-level standardized reading assessment and scores were compared to the previous year’s scores. Of the 75 students in the treatment group, 48 (64%) made at least one level increase on the standardized assessment, while 26 (35%) achieved the same score, and 1 student (1%) performed worse than the previous year. For the 247 students in the control group who participated in the traditional reading interventions, 30 (12%) improved by one or more levels, 181 (73%) achieved the same score, and 36 (15%) performed worse than the previous year (Fisher and Frey, 2014).

These data indicate that the close read strategy is an effective way to increase student reading skills and could help students decode essay prompts for the ACT and DWA.

The close read format we used involved annotation, underlining of main ideas and highlighting vocabulary words. I also added a reading worksheet with text-based questions and a section for students to define their chosen vocabulary terms. We used these practices in the two treatment units to help decode readings about complex scientific topics.

The Claim-Evidence-Reasoning (CER) Framework

The CER framework was the second CAT chosen to help students use evidence to support their claims in written work. In a 2011 study of fifth through eighth grade classrooms, McNeill and Krajcik found that students lack proficient argumentation skills and educators are not using a specific, consistent framework to guide students toward proficiency in the practice. They developed the Claim-Evidence-Reasoning (CER) framework to assist students and teachers in using evidence to support arguments. An analysis of literature on the topic shows that this is a problem which has long existed in the classroom.

The CER framework is a simple format to use with students. McNeill and Krajcik (2012) designed a series of worksheets where students can fill in the blanks for each section when trying to support a claim. These are mostly used in lab write-ups after students have collected data and help them make a connection between their data and the ultimate conclusion of the investigation. It helps students answer the question, “what do your data tell us about the phenomenon?” A “claim” is defined as a statement about the

results of a conclusion. “Evidence” is defined as scientific data used to support the claim and “reasoning” is defined as an explanation or justification of why the data support the claim (McNeill and Krajcik, 2011). Having students work through these steps in lab activities or when answering critical thinking questions helped them improve in their use of evidence to support arguments (McNeill and Krajcik, 2012). I chose this framework as one Classroom Assessment Technique (CAT) to see where students were already using evidence to support their claims and measure any changes or improvements throughout the action research project.

Needs Assessment

To assess the need for an instructional change in my classroom, I surveyed students about whether they were confident in their argumentative writing skills and if they thought they could use additional help outside of their English classes. Of the 39 students surveyed, only six agreed they could use help improving their skills (Figure 1).

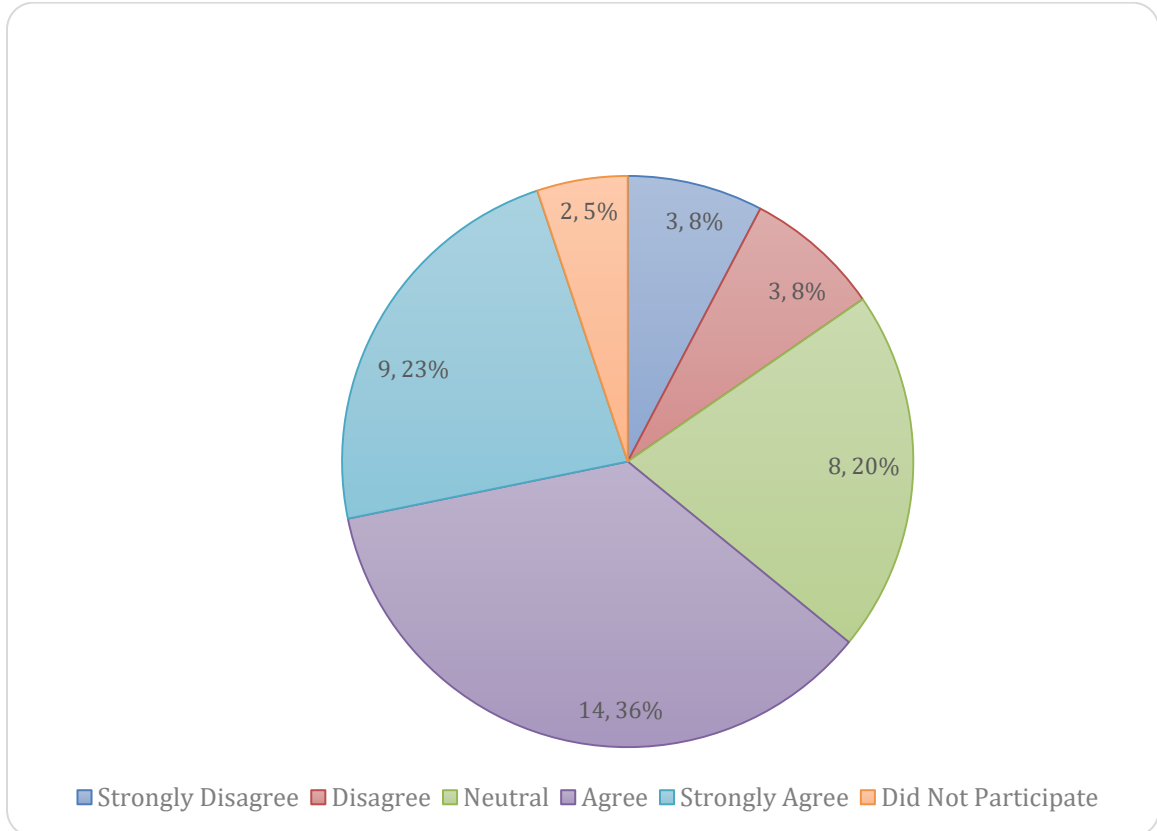


Figure 1. Needs Assessment. Students responded to survey question “I am confident in my argumentative writing skills and I do not want any additional help”, (N=39).

However, when I compared student answers on the survey to their historic scores on the District Writing Assessment, only 17 were at or above the proficiency level during their ninth-grade year. The six students who agreed that they could use some help were already at the proficiency level or above, but still wanted to improve more. This put me in an awkward position because I wanted to help the students improve, but many were not excited about the prospect. I chose to focus on just two units of study (ecology and microbiology) in which to incorporate close reading strategies and CER frameworks in hopes of increasing student skills at evidence-based argumentation.

METHODOLOGY

This classroom research project was designed to examine the effects of CER frameworks and close reading strategies on the use of evidence in argumentative writing activities. The study was reviewed and approved by the Montana State University Institutional Review Board in the spring of 2017 and was implemented in the 2017-2018 school year with two sections of tenth grade biology.

Participants

Fifty-four students enrolled in Biology I courses at Helena High school in Helena, Montana were used in this study. They were an average group from the entire population of the school. This investigation assessed how an average student can improve his or her research and writing skills on complex topics that tend to be misunderstood in science.

Goals and Data Collection Techniques

Two troubling problems were identified in my classes that are probably related: First, somewhere in their education, students have learned incorrect information about biological concepts that they deeply believe. Second, no amount of convincing by me can change these misconceptions once engrained in a student's brain. When I graded the District Writing Assessment in 2017, this lack of ability to use logic and reason to support a claim showed in their argumentative writing skills. I was unsure about how to help students tackle opposing information and think about science topics critically, but through my research for this classroom project I decided the solution to these problems would be to teach students, through the process of research, reading, and argumentative writing, to seek the truth about concepts where they see conflicting viewpoints. Which

viewpoints can be supported with facts and data and which cannot? Which concepts are generally accepted in the scientific community and which are not? What are the reasons that these concepts may be faulty? What proof supports their original ideas and where did their misconceptions come from? I focused on three main goals and one assessment tool (Table 1).

Table 1

Classroom Instruction Goals and Assessment Tools

Instructional goals:
1. Improve student skills using evidence to effectively support arguments 2. Increase use of evidence and research to support arguments in discussion sections of labs and bell-ringer questions 3. Build skills in reading and annotating scientific articles to gain deeper understanding of complex scientific topics
Assessment tool:
Student scores on the fall and spring District Writing Assessment (DWA)

Intervention

After determining the goals for this project, I designed Classroom Assessment Techniques (CATs) for achieving these goals and measuring student improvement. Students participated in three writing assessments and three classroom treatments throughout the year to improve their use of evidence in argumentation. First, students were given a district writing assessment (DWA) in which they were measured on their ability to write an argument using evidence (Appendix A). This assessment provided a baseline for their abilities and was used as a summative assessment of their growth in forming complex arguments. Second, students were given articles on complex science topics to read and analyze using the close reading format (Appendix B). These were then discussed in class and reinforced with videos, notes, and activities where applicable and used as research sources for their evidence in lab write-ups and essay projects. Students

were given Likert surveys (Appendix C) before and after the second treatment. Lastly, students were asked to complete discussion and conclusion sections in their lab notebooks using the CER format modified from McNeill and Kajcik, 2011 (Appendix D) and to complete bell ringer questions in their notebooks using evidence to support a claim for which no specific data were provided. They were then assessed using the fall and spring district writing assessment and an in-class essay on an ecological topic in the same format. All data collection instruments used in this action research project are listed below (Table 2).

Table 2
Data Triangulation Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
How does the use of evidence-based argumentation in science class impact students' scores on ACT-like writing assessments?	Pre-Intervention Writing Assessment	Ecology Argumentative Essay	Post-Intervention Writing Assessment
Sub-question 1: Will the use of claim-evidence-reasoning models increase the frequency of evidence used to support conclusions in lab write-ups and bell ringers?		Student Artifacts (formative assessment bell ringers)	Student Artifacts (student lab write-ups—discussion)
Sub-question 2: Will the use of close reading strategies and argumentative writing lead to deeper understanding of complex science topics?	Pre- and post-Likert Survey (close reads and attitude)	Student Artifacts (close read analyses)	Student Artifacts (student lab write-ups—discussion)

Data Sources

Students take the DWA in the fall and spring each year in grades 9-12. Juniors take the ACT in the spring in place of the DWA. The writing samples are scored on a scale from 1-6 based on the ACT grading rubric (Appendix A). These scores were used to determine any improvement on evidence-based thinking in my students. Two topics

identified last year as areas of high student misconception during my preliminary research were ecology (specifically in the areas of invasive species management, climate change and its effects on ecosystems, and the role of keystone predators) and microbiology (management of infectious disease, the role of bacteriophages in treatment, and the benefits of vaccination). These are the topics students addressed in the close reads, lab investigations and CER frameworks in this classroom research project.

After completing close reads on three ecological topics relevant to Montana and our area in general, the students chose a complex ecology concept and researched it further. Students wrote argumentative essays with research supporting both sides and an explanation of why their opinion makes the most sense. During this investigation, I guided the students through the process of choosing reliable sources and citing them properly with the help of our library staff and instructional coach. We also reviewed the ACT writing format for the argumentative essay and discussed ideas for organizing their papers (Appendix A). Each student completed a pre-write outline that was designed to walk them through the organization for an argumentative essay (Appendix A) and received a grade for their outline. Once the outline was completed, the essay was typed and submitted for grading. Students had the option of revising the paper once, but only two students chose to revise their papers for a higher grade.

Likert surveys were used in two ways—one survey was given about the close read strategy and one was given about the class in general. Students were asked to answer these at the beginning of the year and again at the end of the year to measure any changes

in attitude or outlook toward the interventions, science class, and writing and reading in general.

Data Collection Timeline

This investigation took a full year to implement. Planning and background research were completed in the spring of 2017, and data collection began in the fall of 2017 using the basic timeline below (Table 3).

Table 3
Project Timeline

Month	Treatment/Task
September	Students take Fall DWA Likert pre-survey
October: Treatment Unit A Ecology	Introduce Close Reading Start Claim-Evidence-Reasoning format and bell-ringers Ecology topics argumentative essay
November	Fall DWA scores available
February: Treatment Unit B Microbiology	Continue Close Reading and Claim-Evidence-Reasoning Microbiology lab activities: Bacterial survey of our school Effectiveness of cleaners and antibiotics on bacteria control Bacteriophage research project with MT Tech Lab write-ups assessed for use of evidence and reasoning
March	Likert post-survey
April	Students take spring DWA
June	Spring DWA scores available

September 27-October 12, 2018

All students in the district took the fall district writing assessment in their English classes on September 27. The assessment question was on “motivation” and was a particularly abstract prompt topic (Appendix A). I attended the grading training sessions on October 2-9 and graded the essays on October 11 using the ACT argumentative essay rubric (Appendix A). These results were then analyzed by our district data and assessment administrators and shared with me in late October. During this time, I also

introduced the CER format for the bell ringer questions. Students were asked to answer Q1 and Q2 (Appendix D) in their lab notebooks using the CER format (Appendix D). We went over the answers and discussed in class the fact that some people had different answers than others, but each could be equally correct if their claims were supported with evidence, reasoning and proper research.

October 13-18, 2018

On October 13, students participated in the Likert pre-survey (Appendix C) on their general attitudes about science class, writing and reading and the argumentative writing process. This provided a general gauge of their opinions and ideas for me about how to best apply my treatments to maximize effectiveness. From October 16-18 we did our first close read on an article about wolves as keystone species in Yellowstone park and discussed. We used online videos and notes to delve into the topic further, then students were asked to answer Q3 (Appendix D) in their lab notebooks. This question was more difficult than Q1 and Q2 because it required familiarity with the vocabulary of “keystone species” and “dominant species” specific to wolves and willows. Students were encouraged to use their close reads and video notes as research citations to support their reasoning and add specific data to their notebook responses.

October 25-31, 2018

Students took Likert pre-surveys specific to the close reads, writing and CER practices to assess their attitudes toward these interventions. We also completed two more close reads (Appendix B) on complex ecological topics—wildfire management and

invasive species—that are current issues of concern in our community and completed Q4 and Q5 (Appendix A) in lab notebooks.

Students were then asked to complete an argumentative essay on one of the three topics we investigated: wolf management, wildfire management and invasive species introduction. They were given one day of class to go over the prompts (Appendix A) and review their notes to choose the topic they wanted to address, then complete a pre-writing worksheet to help organize their ideas (Appendix A). They were then asked to type a formal argumentative essay in the ACT format and turn in within two class periods. This is double the amount of time usually given for the ACT or DWA, but I also required in-text citations and research in this essay (which is not required in the ACT or DWA). In addition, the ecology topics were not as familiar to the students as the topics usually chosen by the ACT and DWA for their universality.

January 22-February 21, 2018

Students completed CER bell ringers Q6-Q11 (Appendix D) on viruses, bacteria, and infectious disease. Discussion and conclusion sections of three labs were evaluated using the CER rubric for research and evidence to support their reasoning and claims. First, we collected bacteria from around the school and identified areas that had more bacteria than others and areas that had greater bacterial diversity. Next, we tested the effectiveness of certain cleaners, mouthwashes and antibiotics at inhibiting the growth of *E.coli* bacteria. Students designed their own experimental procedures, collected data according to their own protocols and analyzed and interpreted the resulting data using the CER format.

Last, we collected soil samples and surveyed them for bacteriophages that could kill *smegmatis* bacteria. This was a three-day project with researchers from Montana Tech. During this section, students also completed a close read on antibiotic-resistant superbugs, emerging diseases found in melting permafrost and the potential medical applications of bacteriophages including treatments for antibiotic-resistant bacteria and gene therapy. Their lab write-ups were expected to include data from these close reads as well as the lab activities.

March 1, 2018

Students completed a Likert post-survey (Appendix C) about the effectiveness of the close reads, writing practices and CER format to assess their attitudes toward these interventions.

April 25, 2018

All students in the district took the spring DWA on distracted driving (Appendix A) in their English classes.

May 25, 2018

Data from fall and spring DWA was made available for analysis.

June 4, 2018

Students were given a Likert post-survey (Appendix C) on general attitudes about science class, writing and reading, and the argumentative writing process. Throughout the year, surveys, CER bell ringers and lab discussion sections were analyzed for patterns of improvement. At the end of the year, data were statistically tested for significance using t-tests and normalized gain.

These data collection tools were analyzed and results were recorded throughout the year. I kept spreadsheets of the Likert responses and CER bell-ringers, but these were not graded for points in the class. The lab discussion sections were graded and students could see their scores on the CER format for these labs, so they knew where to improve for the next lab write-up. I used the gradebook to record data on the ecology essay. A discussion of the effectiveness of these CATs follows in the section below.

DATA AND ANALYSIS

Data collection included pre- and post- Likert surveys, formative assessments on CER bell ringers and lab write-ups, and summative assessments on the district writing assessment and an ACT-style argumentative essay about an ecology topic. These data were collected to determine whether these specific classroom practices would help students improve their argumentative writing skills on the District Writing Assessment.

Based on anecdotal evidence, my students disliked practicing their writing skills and absolutely hated doing it in science class. “This isn’t English!” was often the complaint when I assigned an article to read or a paper to write. I tried using the argumentative essay format with my sophomores last year and got very few papers that fit the format or showed an understanding of how to write an argumentative essay. This year, I prepared the students using close reads, CER frameworks and bell ringers in science class.

Likert Surveys

Two Likert surveys were used: one specific to the CER and close read process, and one which asked about their general opinions about science, reading, writing and the

argumentative essay process (Appendix C). Answers were scored on a scale of 1-5: Strongly disagree (1), Somewhat disagree (2), Neither agree nor disagree (3), Somewhat agree (4), Strongly agree (5). I have selected some of the more interesting questions and answers to look at more closely (Tables 4 and 5). Question 11 from the Modified Likert survey (Appendix C) showed the most improvement on student confidence in using evidence to support arguments, though a paired t-test shows that the change is not statistically significant ($p=0.15$).

Table 4

Student Likert Survey Results—Confidence in Using Evidence to Support Arguments

	Pre-Intervention	Post-Intervention	Confidence +/-
1-Strongly Disagree	36%	15%	-21%
2-Somewhat Disagree	25%	18%	-7%
3-Neutral	14%	8%	-6%
4-Somewhat Agree	22%	35%	+13%
5-Strongly Agree	3%	24%	+21%

Note. I am comfortable using data as evidence to support an argument ($N=34$).

Students comfort level was low on the pre-survey, but after the interventions many students experienced increased comfort using data as evidence to support an argument. They also increased slightly in their feelings about doing well on the written assessments. Many of the students answered that they did not like to read or write in science class, but found that with practice, they increased in confidence. On question 15 from the general Likert survey, students quantified their feelings about their level of effort on the writing assessments (Table 5). This improvement was also not statistically significant based on a paired t-test analysis ($p=0.17$).

Table 5

Student Likert Survey Results—Pride in Effort on Writing Assessments

	Pre-Intervention	Post-Intervention	Change (+/-)
1-Strongly Disagree	19%	9%	-10%
2-Somewhat Disagree	27%	21%	-6%
3-Neutral	32%	38%	+6%
4-Somewhat Agree	11%	18%	+7%
5-Strongly Agree	11%	15%	+4%

Note. I am proud of my efforts on in-class writing assignments and the district writing assessment (N=34).

These data may indicate that students who didn't show a significant improvement in their scores on the DWA this year may be able to improve in the future because of the treatments. If they are more confident in their abilities to support claims with evidence and take more pride in their efforts on the assessments, maybe they will reach proficiency before they graduate. In an open-ended survey of their impressions of the practices, many of the students who completed the practices felt like they were helpful. One student remarked, "I really liked writing down opinions from both sides and using evidence." Another student mentioned the specific CATs noting that "[the close read process] is a helpful tool for understanding difficult readings and finding evidence to support my arguments."

Claim-Evidence Reasoning in bell ringers and lab write-ups

In addition to the reading and writing interventions, I used the CER framework described by McNeil and Krajcik (2011) to encourage students to connect data collected during lab investigations to their conclusions. The template (Appendix D) provided a

format for their answers, but then students were expected to translate their argument to paragraph form for their lab discussion and conclusion sections. These paragraphs were assessed on a scale of 0-3 using the CER grading rubric (Appendix D). Students did show improvement over the three labs activities using data to support their evidence in the discussion sections of their labs write-ups (Figure 2). Scores indicate slight improvement from the first lab write-up to the last with a normalized gain of 0.56.

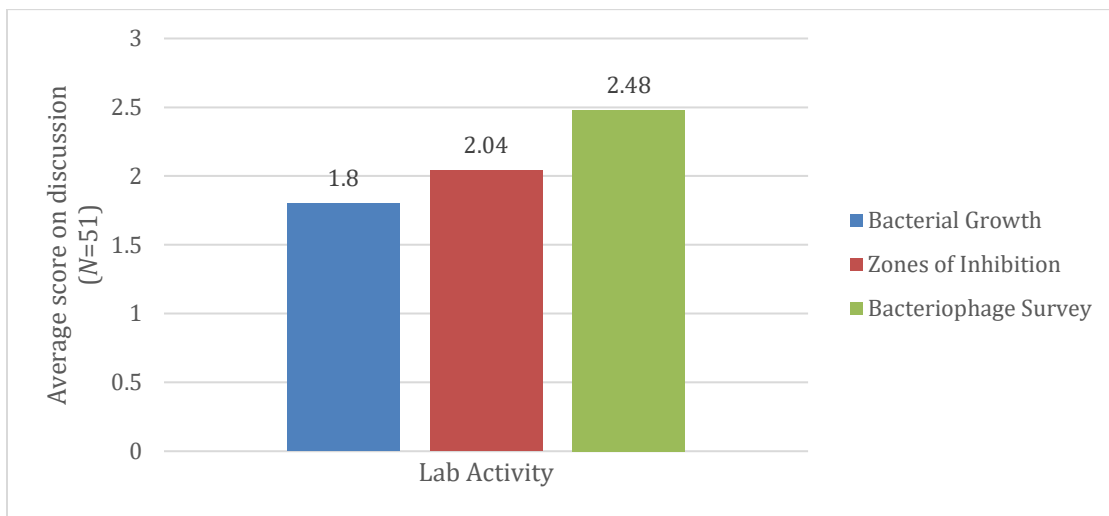


Figure 2. Average student scores on three discussion sections. Were data used to support arguments in lab write-ups?, (N=51).

Finally, the CER practices with bell ringers (Appendix D) did show an improved understanding over time of the process of using evidence to support arguments. For Q1 and Q2, I got a lot of circular arguments in the journal answers. For example, one student answered that “Things are alive because they are living,” while another said, “They just are. There are no rules about it.” These are the types of arguments we see on the DWA that lead to a low score—no data, no evidence, no reasoning to support the claim. On Q2, still before we started the treatments, I think students had an easier time making an argument because the question was asked on a smaller scale. When prompted to choose

from the list which items were living and why, students were able to make a claim about their answer, but not always support them with evidence or reasoning. For example, one student answered that water was living because it is full of living things. This answer provides an argument but doesn't connect to any specific evidence or reasoning. Another thought a seed wasn't alive because it doesn't breathe and living things have to breathe. The second answer shows evidence and reasoning, even if the evidence may be faulty. My favorite answer to this question came from a student who argued that lettuce could not be living because "eating something that was still alive would be wrong and gross." We went through these answers together and discussed what evidence could support people's claims.

After the first two questions, I gave the students the CER format and we discussed the merits of using evidence and reasoning to support arguments. I showed them the CER grading rubric and explained how their bell ringers would be graded. The students had just taken the DWA and were not very receptive at first to doing more argumentative writing, but as we went through the next few bell ringers, they warmed up to the idea. A few students got the format right away and never had a problem with it for the rest of the year. Others struggled with the differences between what constituted evidence and what constituted reasoning.

Questions 1-2 had the lowest average CER score, probably due to the fact that the format had not yet been discussed. Two students still scored a three on the first questions and maintained threes throughout the year. Some students did not do the bell ringers and were scored as a zero; these scores were not removed before calculating the average in

order to maintain the total at 34 scores for all questions. Students showed an overall trend of improvement and did best on Q6 with a drop at the end on Q11. Q11 was one of the more technical and difficult questions with subject-specific vocabulary that was difficult for some students to access. When we discussed our answers, many students had not written anything, which led to a drop in the overall scores for the class. The question was used based on the assumption that students had completed the close read on phage therapy, but many had not completed their homework. Averaged scores on the bell ringer activities are shown in Figure 3 below.

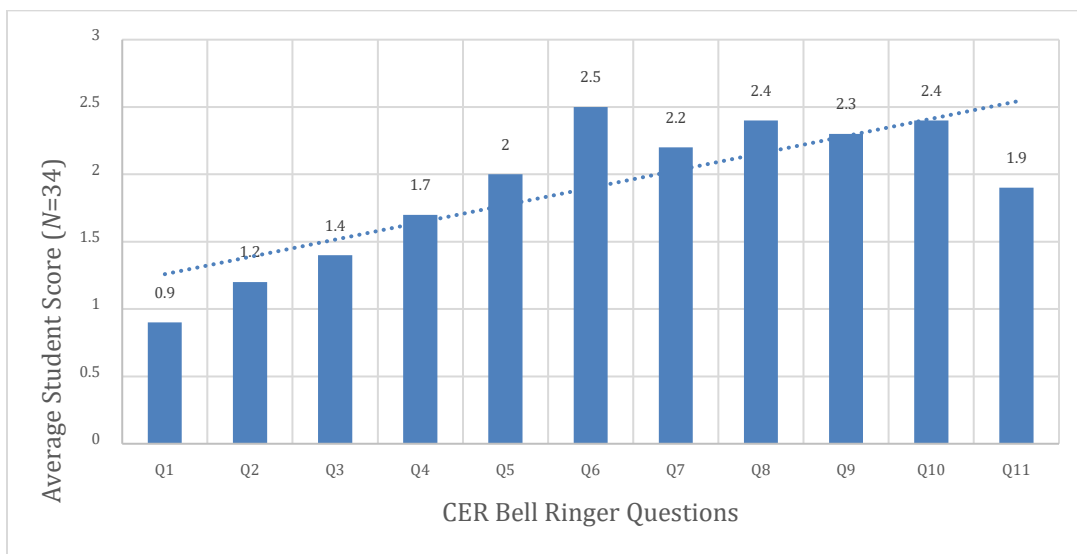


Figure 3. Student scores on CER bell ringers over time, ($N=34$).

Q1 and Q6 were analyzed more closely for whether evidence was used to support the student's claim (Figure 4). Q1 had only 12 students who were able to use some form of evidence to support their claims while Q6 had 28 students use evidence to support their claims. This could be due to differences in the wording of the questions and also differences in student comfort with the topic. We had already read about viruses and

discussed them in detail when I asked students to answer Q6, whereas Q1 was asked without much background information given.

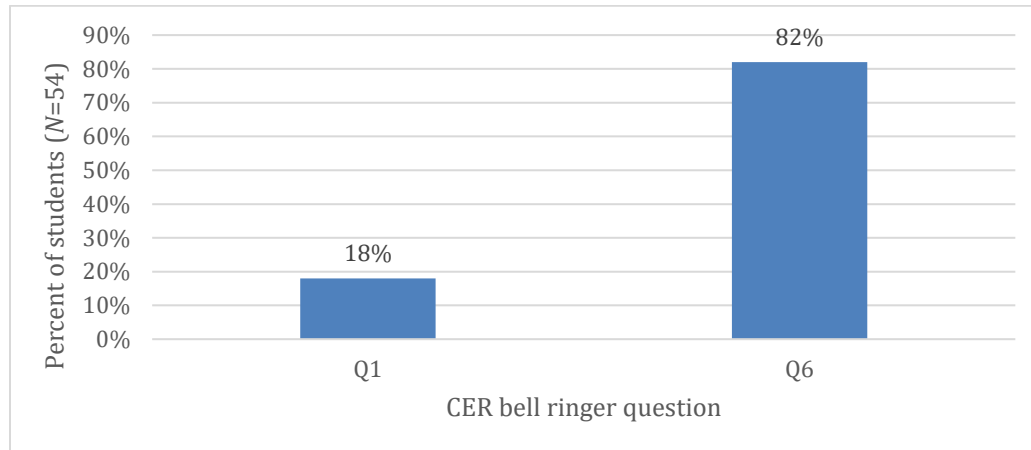


Figure 4. Percent of CER answers using evidence to support claims, (N=54).

Overall, the CER framework helped students improve on their use of evidence in arguments applied in the classroom settings of lab write-ups and bell ringer questions. Normalized gain of Q1 and Q6 show an improvement of 76% in use of evidence. The area that still plagued many students was connecting the evidence to reasoning. This is an area that I didn't focus as much on in class or in my grading, so only a handful of students had mastered this skill and were getting consistent threes on their CER writing assignments. Others improved on claim, evidence and reasoning, but never connected their research directly to their evidence.

District Writing Assessment and Ecology Essay

The Helena School District Writing Assessment (DWA) was used as a statistical measure of improvement from the beginning of the year to the end. The writing prompts are given in a standard format and a set Lexile for all students district-wide regardless of year in school or special education status. Students have one class period (50 minutes) to

read the prompt and construct a response. I used the same formatting guidelines for the ecology essay assigned in my class but gave the students more time to complete the assignment because I required them to research the question and add cited data to their arguments. At the end of the year, I compared the improvement rates in their DWA scores from the beginning of sophomore year to the end, and then compared these rates to the average student improvement across the sophomore year using a parametric t-test. I hoped to see some growth in their writing abilities and their use of data to support arguments.

When I received the scores for my 54 students, only 34 had actually completed both the fall and spring DWA (Figure 5). This was a surprise to me, but 23 students had

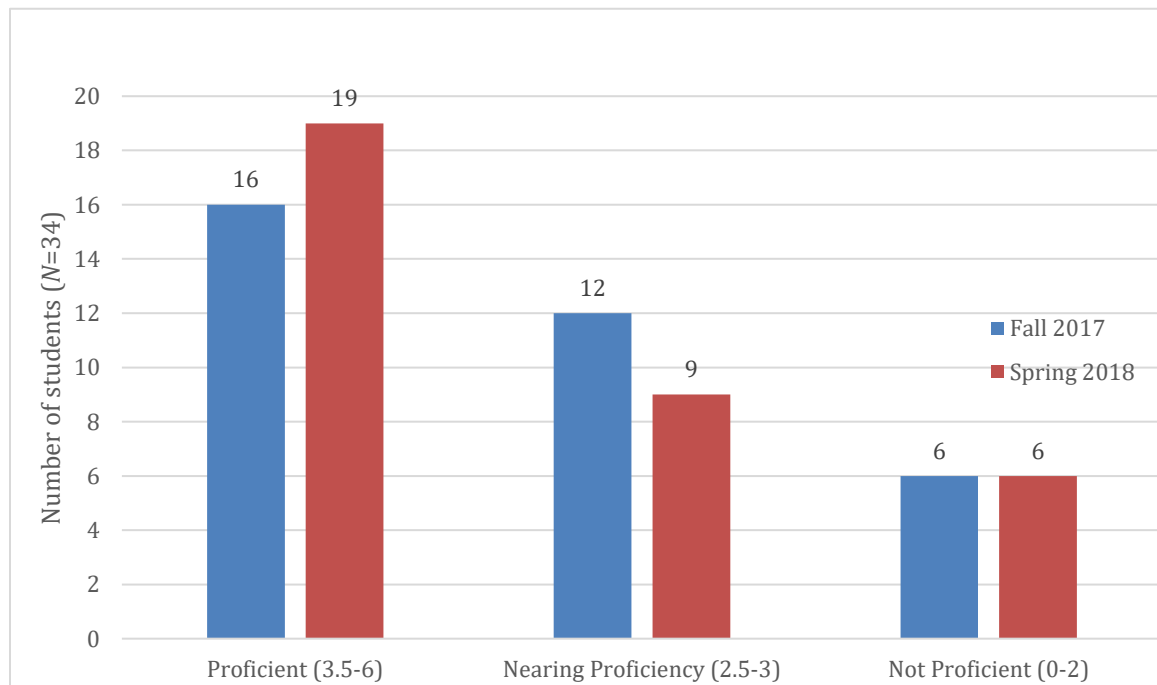


Figure 5. Student scores on Fall 2017 and Spring 2018 DWA, (N=34).

either moved, dropped out of school, or just missed one or the other assessment and never come in to make it up. This reduced my study group to a smaller sample size which

made it difficult to determine statistical significance of any improvements in their scores. From Fall to spring, three of the 34 students moved from nearing proficiency to proficient. There was very little or no improvement for the six students who scored lowest on the assessment.

These data support statistical significance in the effectiveness of the treatment to improve student scores on the DWA. The mean scores were a 3.00 in the fall and a 3.43 in the spring. The standard deviation for the fall scores was 0.82 and, in the spring, it was 1.02. A paired, two-tailed Student's t-test for significance scored below the 0.05 benchmark showing statistically significant improvement in overall student achievement on the DWA; $t(66)=2.00$, $(p=0.019)$. A normalized gain analysis of the averages which stated that $(g) = (3.43-3.00)/(6-3.00)$ showed a gain of 0.15 from fall to spring.

As a class percentage, 47% of the students started the fall with a proficient score with 35% nearing proficiency and 18% not proficient (Figure 6). By the spring, we had improved to 56% proficient with only 26% nearing proficient, with the same 18% of students not reaching proficient levels.

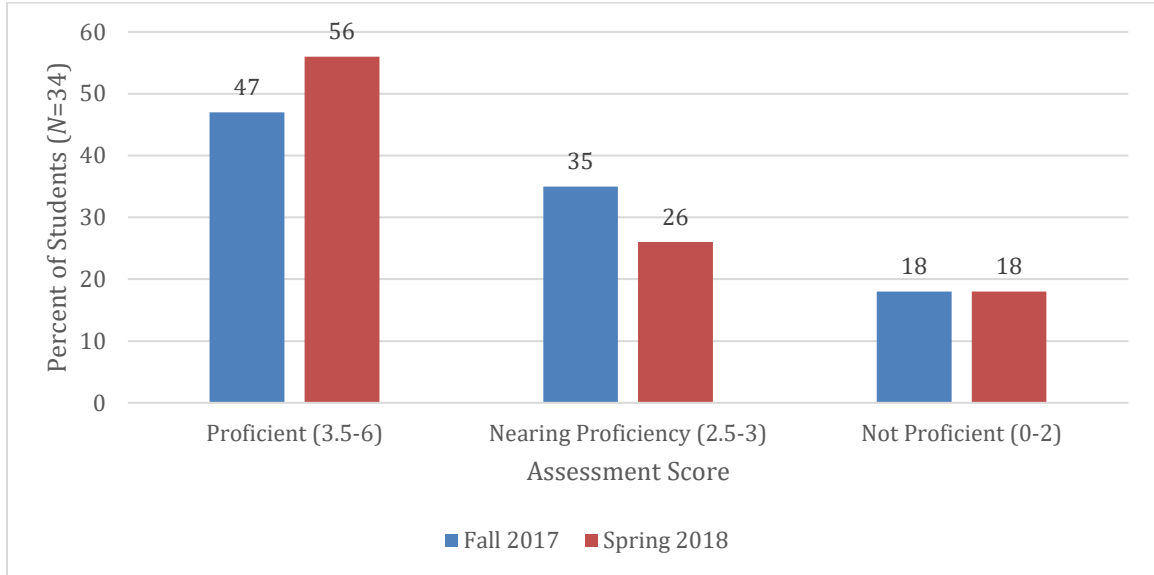


Figure 6. DWA scores by percent for students in my classes, (N=34).

However, these modest improvements are not more impressive than the entire HHS sophomore class (Figure 7).

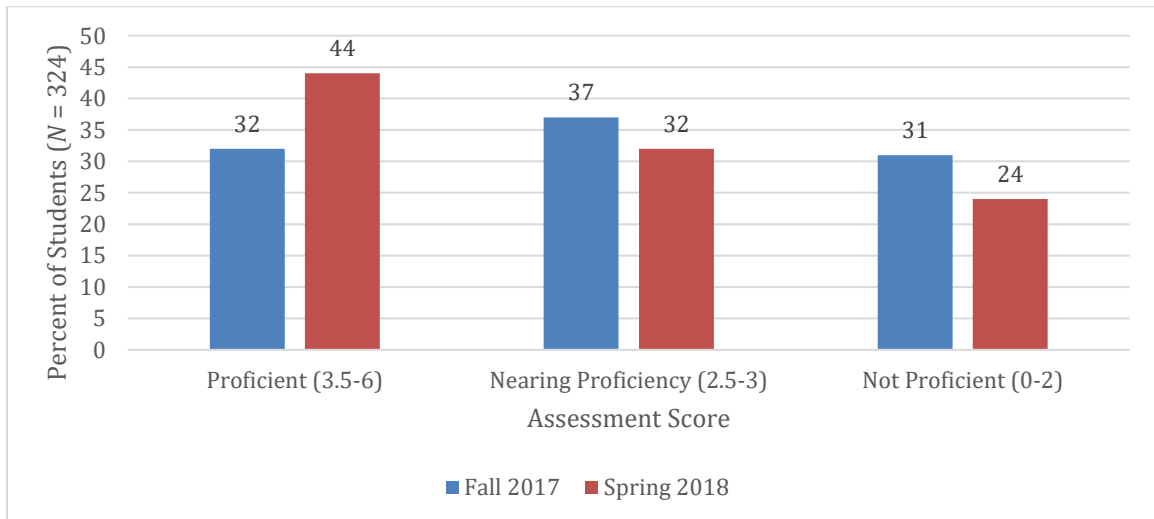


Figure 7. DWA scores by percent for all HHS 10th grade students, N=324).

Overall, the sophomore class showed a greater improvement in DWA scores from fall to spring. Only 32% were proficient on the fall assessment with 37% nearing proficiency and 31% not proficient. By the spring, 44% had reached proficient with 32% nearing proficiency. The non-proficient students were reduced to only 24% of the

sophomore class. Although my classes did not show the same levels of improvement—especially in the non-proficient group—there are indications that the treatment helped some of the students gain modest growth in their DWA scores (Figure 8).

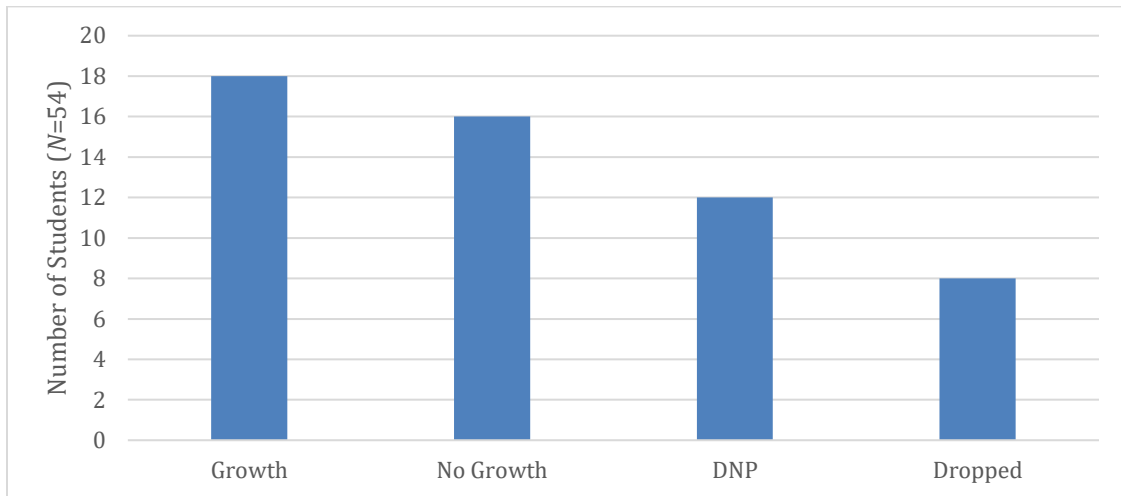


Figure 8. Change in student DWA scores between Fall 2017 and Spring 2018, (N=54).

Of the 54 who participated in some of the treatments and took one or more of the DWA assessments, 18 showed growth (+0.5 or more) in their score between fall and spring. Sixteen students showed no growth and 20 either did not participate (DNP) or dropped their enrollment at our school. Of the 20 students who dropped or did not participate in one or more of the assessments, three were showing signs of growth based on their ecology essay and scores from freshman year. Five more stayed stagnant, but already at the proficient level and did not necessarily need improvement.

Of the 34 students with scores from fall and spring of their sophomore year, 32 had also taken the fall and spring DWA during their freshman year. When I added these scores in and their scores from the in-class ecology essay, these students show an overall trend of improvement—especially on the ecology essay. It may be due to the fact that students were given the chance to research the topic in more detail for the ecology essay

before composing their arguments and also had more time to complete the writing portion. This group improved from a mean score of 2.5 in the fall of their freshman year to a 3.5 by the spring of their sophomore year for a normalized gain of 0.40 (Figure 9).

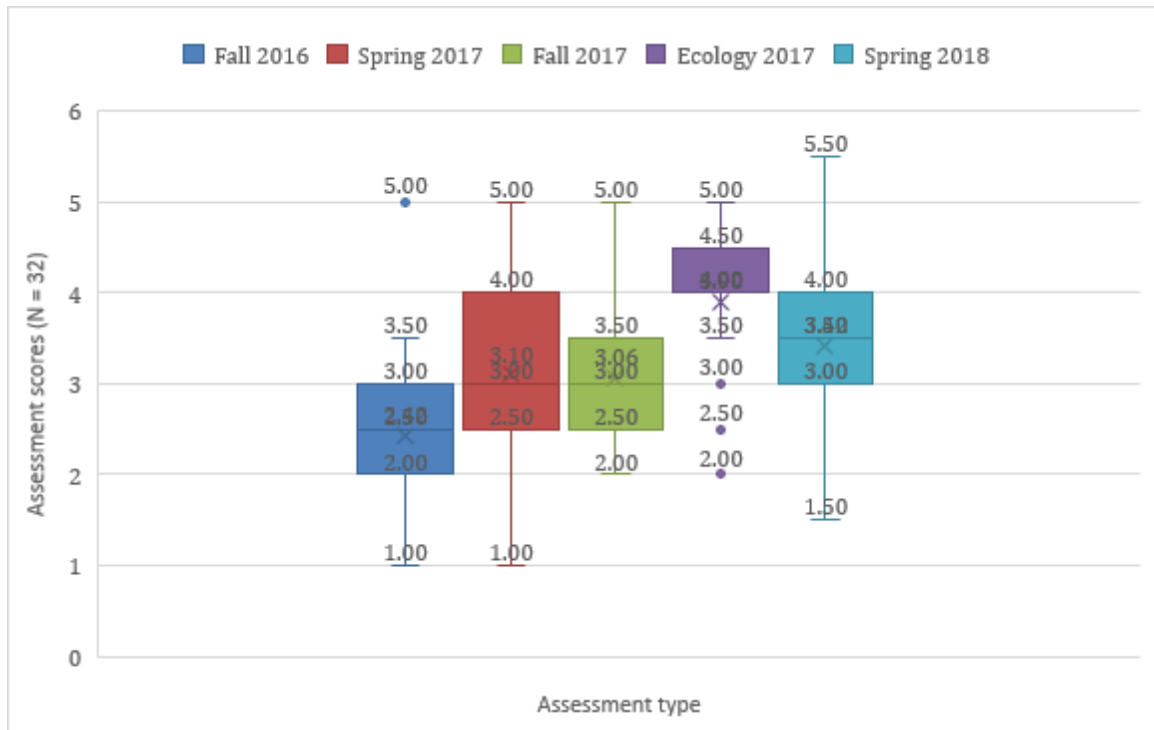


Figure 9. Improvement on ACT-type writing assessments over high school career, (N=32).

Overall, about half of my students showed growth in skills writing arguments using evidence between the fall and spring DWA. The students who were not proficient before the intervention still did not reach proficiency, but some showed an increase in the use of evidence to support arguments in CER bell-ringers and lab discussion sections. Two students who did not reach proficiency did show a growth of at least 0.5 on their spring DWA. Three students who were nearing proficiency reached the proficient level and all the students who were already proficient on the DWA in the fall increased their scores by at least 0.5 on the spring DWA.

INTERPRETATION AND CONCLUSION

This investigation was at times confusing and difficult, but it showed me that students who used the CER format, completed the close reads, and applied these skills to their lab write-ups were able to improve their scores by 0.5 or more on the DWA even if they were already proficient. Students who did not participate in all or most of the treatments did not improve. This seems like a simple conclusion, but before this research was performed, I never practiced these specific skills in different formats in classroom instruction. For example, when students were assigned an essay, I expected them to know how to read articles and add reliable research to their argument. When they write a discussion section in a lab write-up, I expected them to use data to support their conclusions. When students did not do these things, I assumed it was their choice to leave that information out—either because it was too difficult or because they didn't want to spend the time to do the assignment correctly. Now I see that many students—even the most high-achieving students who always do their work and try to get it right—can improve their use of evidence in argumentative writing through the use of CER frameworks in other settings. In fact, the treatment showed the highest level of effectiveness with the already-proficient group where 100% of these students improved on their argumentative writing skills over the year. These students also responded the most positively to the treatments when surveyed.

Positive responses indicated that students who completed the practices often found them useful. Student quotes from the post-Likert included the following responses:

- “Highlighting main ideas was useful. It made things way more easier.”
- “The close read made me pay more attention to headings and titles.”
- “Once I got used to using evidence in my labs it was really easy to finish the write-ups.”
- “I felt like I did a better job on the spring writing assessment and I’m proud that I improved over the year.”

These comments suggest that using reading and writing strategies in the science classroom setting may have helped some students improve their skills and their attitude toward argumentative writing using evidence.

Some of the students who gained proficiency in their writing skills did not enjoy specific practices. The close reading strategy was particularly hated, probably in part because I chose articles that were too easy and too long. One student astutely noted, “Use close reads for harder texts that we have more trouble understanding—these were too easy.” Others just showed a general dislike for the technique, no matter whether it helped them or not. Comments included the following:

- “We don’t like doing close reads. It wasn’t helpful and makes it feel more like a chore.”
- “It’s not very fun.”
- “I don’t like reading things multiple times.”
- “It didn’t fit my way of learning—don’t do it again.”
- “Never make us do this again.”

After analyzing my data, I returned to the literature on close reading and found a 2013 study in the *Journal of Adolescent & Adult Literacy* which helped explain some of the issues with the close reading strategy I implemented in this study. Hinchman and Moore reviewed a variety of literacy strategies for effectiveness and found that the close read process can be discouraging to struggling readers. “We worry that many will struggle to do so, whether it’s due to the texts’ challenging linguistic or conceptual demands or the students’ abilities to perform particular close reading tasks.” An additional study by Allington & Gabriel in 2012 found that ESL students, striving readers, and students with special needs were particularly vulnerable to failure with the close reading strategy. Because most of their previous reading interventions focus on decoding and low-level comprehension tasks, they can struggle more than higher-level readers when asked to go through all the steps of a close read. They note that “all students are likely to become frustrated if they lack sufficient skills and strategies to participate reasonably in close reading discussions and to improve in ways they can apply to future readings” (Allington & Gabriel, 2012).

The other problem with the close read strategy could be the topics I chose. Since my mid-level and high-level readers showed a general dislike of the process, it’s possible they were just disinterested in the particular topics I chose. Hinchman and Moore note that “youths do well when they read what they find interesting and valuable and when they can connect what they are reading with their personal lives, other texts, and their knowledge of the world” (2014). If the students did not find the topics interesting, it

could be difficult for them to see the value in using a close reading strategy to better understand the concepts.

However, there were still four students who participated in most of the treatments who showed no improvement on their DWA scores. Three of these four students scored better on the ecology essay than they did on the spring DWA which may be due to the increased time given for writing or the increased amount of background knowledge about the topic. There may also be a lack of effort from a few students who did not want to do the treatments or try their best on the assessments. Comment from these students on the post-Likert survey were mostly negative and included the following:

- “I believe this is a waste of time and benefits very few people.”
- “I didn’t like all the writing.”
- “This class is too hard. You make us do something like every day.”

These comments reveal a lack of desire by students to use their time to improve on their writing and reading skills in science class. These four students also indicated a dislike of school in general. One commented on the open response section of both the pre- and post-Likert survey, “I hate school.” Its possible these students will come back to the strategies later in their learning careers, but the interventions did not help them during this study.

Overall, the students who participated in the treatments improved their ability to use evidence to support their arguments over the course of the year. A few students also told me they enjoyed the discussions and think the practices helped them during the spring DWA because they were looking for evidence they could use to support their

claims. The treatments did not help all students on their ACT-like writing assessments, but it did help almost all of the students add evidence to their discussion sections and CER bell-ringers.

Improvements and Future Interventions

This research project helped me understand some of the benefits and limits of the treatment tools used. I do intend to continue using the CER frameworks for lab write-ups and bell-ringer journaling because they showed the best results of the three treatments. The framework is a simple practice to implement with the students and helped them organize their ideas when answering a question or supporting an argument. It worked especially well in the bell-ringer format because students got lots of practice and enjoyed the resulting discussions about the claims.

In the future, I intend to start with a “fill-in-the-blank” worksheet for the CER, then work up to expecting students to use the practice without much prompting. I also plan to incorporate the fourth level, rebuttal, as described by McNeill and Krajcik (2011) which asks students to provide an assessment of why another point of view is not valid, based on the evidence collected. This will require higher-level thinking skills from my students, as well as in-class practice in a number of different activities and settings, and may lead to improvement on argumentative thinking and writing in their other classes.

The close reading process showed less applicability in my classes, in part due to my mistakes of choosing passages that were too long and too easy for some of the higher-level readers. Close reads are more useful for very short, very difficult passages. I could see using this treatment with very short journal articles—or even just the methods or

conclusions section of a single article. Also, I found that some of the lower-level readers got discouraged very quickly, even with the easier articles, because of the length. It would be useful in the future to use reading level to determine which of two or three short passages to give each student, so the article fit their reading abilities better. The articles did help students with complex scientific concepts, but a different literacy strategy would have been more appropriate in this case. Also, it could be beneficial to use the articles in partnership with the English department, so students felt like they were getting the benefit of reading about science for credit in another class with a reading expert, rather than believing they were doing “extra” work in science class by reading articles.

As for the argumentative essays done in science class in the same format as the DWA and the ACT, I think it is a good practice and should be continued. My colleagues were on board with the essay project this year for the ecology unit and will probably be willing to continue the practice. With the additional essay each year during tenth grade, students will get more familiar with the ACT format and could improve their confidence and skills in time for the spring of their junior year when they write the real ACT assessment. I plan to check DWA scores for my class cohort in 2019 and see if they are continuing to improve their argumentative writing skills and if more reach the proficiency level in time for the ACT during their junior year. Hopefully the interventions we tried in class will stick with them and provide value in their future argumentative writing endeavors.

VALUE

This research project has shown me the importance of going back to reflect on my teaching practices and closely evaluate my assignments and assessments for their merit. In the past, when I haven't given students a framework to follow for supporting their arguments, they didn't do very well providing evidence and reasoning. I plan to add the CER framework to my lab write-up directions and grading expectations and explain to my students each year how the evidence and reasoning strengthen their arguments. This is a skill they should be able to translate into any field. I also want to keep the bell ringer practices because they provided opportunity for discourse and participation from everyone. It was fun toward the end of the year to have students ask each other, "What's your evidence for your claim?" instead of just shouting down another student's argument. It gives me hope because now, I have a better understanding of what to expect and how to help students improve their argumentative writing, not only in science class, but in all areas.

I am discouraged by the number of students who didn't show improvement over the year. I started the process sure that these treatments would lead to great improvements in all students' scores, but when they didn't, it made me wonder why. On our final paper in class, which I did not include in this study, I saw the biggest drop in the use of evidence and reasoning to support arguments in their discussion and conclusion sections. We had been growing plants in small groups and adding variables to see their effects on plant growth. It's a very simple experiment. But for some reason, many students provided no evidence or explanations for their conclusions in their final papers. This was

disheartening to me because I hoped they had learned skills that would carry on to next year, but many had not. I know they can do it, but I don't know why they don't always do it. Perhaps it was due to lack of time or the fact that the year was almost over, but I was hoping to see more consistency in their work after all our efforts this year.

This action research project took a lot of time and energy, but it was an interesting practice. I don't think I will do a project of this scale again, but I did enjoy talking with the students about the trends I was seeing and the improvements in their scores over time. The students who cared about doing well on the ACT and DWA were excited to see their spring scores rise and they did credit some of the improvement to our work in science class. That's enough to make it worthwhile and valuable to me.

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APPENDICES

APPENDIX A

DISTRICT WRITING ASSESSMENT AND ECOLOGY PROMPTS

Fall 2017 DWA Prompt: Motivation

Society has long depended on extrinsic motivators to encourage tasks to be completed, such as parents paying their children to do chores, schools assigning grades for completing coursework, and employers giving paychecks to secure an active workforce. On the other hand, intrinsic motivation, the desire within a person to accomplish something because it is naturally satisfying, has been shown by researchers to be powerful and longer lasting than extrinsic motivators. We take pride in our accomplishments and find pleasure in contributing to society through activities such as volunteering at local organizations or through creative expression in activities like artwork, welding, or carpentry, even though we may receive no external reward. In a society that values extrinsic motivators, how should we understand the role of intrinsic motivation?

Read and carefully consider these perspectives. Each suggests a particular way of thinking about the issue of motivation in society today.

Perspective One	Perspective Two	Perspective Three
People are motivated by external rewards, which is why society has so many in place. Continuing to value accomplishments through tangible rewards will maintain society's creativity, productivity, and advancement.	Since intrinsic motivation has been shown to be the most powerful motivator in the long term, society should limit external rewards which provide only a short-term incentive for individual goal-setting. This will balance both types of motivation.	Society should shift its focus to intrinsic motivations, which helps individuals realize their full potential and encourages them to work for enjoyment, fulfillment, and happiness, rather than external rewards.

Essay Task

Write a unified, coherent essay about the issue of motivation in society today. In your essay, be sure to:

- clearly state your own perspective on the issue and analyze the relationship between your perspective and at least one other perspective
- develop and support your ideas with reasoning and examples
- organize your ideas clearly and logically
- communicate your ideas effectively in standard written English

Your perspective may be in full agreement with any of those given, in partial agreement, or completely different.

Planning Your Essay

Use the space on the back of this sheet to generate ideas and plan your essay. You may wish to consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

Argumentative Essay Pre-Write Worksheet (5 points)

Name _____ Per ____ Due Date _____

Introduction

Interesting fact: _____

_____ Citation on work-cited page:

Background Information on the topic: (basic info, ecosystem details, debates between interested parties, when historical events occurred, etc.) _____

Conflicting perspectives chosen and described in the introduction. _____

Thesis (Claim):

Note – the above information will be part of the introduction- organized with linking between ideas.

Body Paragraph 1 Describe perspective 1 and supporting scientific evidence.

What is perspective 1 _____

Do you agree or disagree with this perspective? _____ Why? _____

What are **two or more** the pros/ supports for this perspectives? (list) _____

(citation) _____

What are two or more cons for this perspective? _____

(citations) _____

Body Paragraph 2 Describe perspective 2 and supporting scientific evidence.

What is perspective 2 _____

Do you agree or disagree with this perspective? _____ Why? _____

What are **two or more** the pros/ supports for this perspectives? (list) _____

(citation)

What are two or more cons for this perspective? _____

(citations)

Conclusion *The job of the conclusion is to accomplish three tasks 1) restate the main idea or thesis (not in exact words, but in a new way) 2) Reword two main points of view in this paper 3) Leave the reader with an interesting final impression. Show the reader why this paper is important, meaningful, and useful. *When reiterating ideas synthesize, don't summarize- don't restate- fit the major points together in a new unique way.*

Rewording of the thesis and why this thesis is important _____

Two perspectives and why there is such strong feelings for each _____

Why is the perspective you chose the most logical choice? _____

_____ Are there statistics to help support? _____

So what- why is this topic important? (policy, regulation, quality of life, etc.) _____

Ecology Prompt 1: Wolf Management in the Greater Yellowstone Ecosystem

The hunting of gray wolves, while originally actively endorsed and encouraged, has become a controversial issue in the western U.S. Opponents see it as cruel, unnecessary and based on misconceptions, while proponents argue that it is vital for the conservation of game herds and protects livestock.

The recovery of the wolf in the northern Rockies remains one of the fastest endangered species comebacks on record. In the mid-1990s, 66 wolves were reintroduced into Yellowstone National Park and central Idaho. As the wolf packs grew, elk and deer populations dropped and willow, beaver, songbird, coyote and trout populations increased. Montana's known minimum wolf population is now a stable 536 wolves in 126 packs. On April 26, 2017, the final federal protections for the gray wolf were removed under the Endangered Species Act. Each state manages wolves differently.

Wyoming classifies the wolf as a predator species that can be shot without a permit. Montana manages wolves similarly to bears, mountain lions and other wildlife species that can be hunted or trapped with a permit. Wolf hunting licenses cost \$19 for residents and \$50 for nonresidents, while trapping licenses costs \$20 for residents and \$250 for nonresidents. The combined maximum hunting and trapping bag limit is five wolves per person. **Knowing the impact wolves have on the ecosystem in and around Yellowstone, what is your opinion about the current and future management of this species?**

Read and carefully consider these perspectives. Each suggests a particular way of thinking about the issue of wolf management.

Perspective One	Perspective Two	Perspective Three
Wolves are a natural part of the ecosystems and should be allowed to exist within their historic ecosystems without limit. Hunting and	Wolves are a natural part of the ecosystem, but pose threats to livestock and game animals. They should be managed in an organized way that takes into consideration all stakeholders	Wolves should not exist in the natural ecosystem. They are no longer necessary to help sustain the environment and must be exterminated. Hunting and trapping of wolves should

trapping of wolves is unnecessary and damages the work done to reintroduce the species.	interests. Limited hunting and trapping is an efficient way to manage their populations.	be unlimited in Montana and the rest of the Rocky Mountain West.
Essay Task Write a unified, coherent essay about the issue of wolf hunting and trapping. In your essay, be sure to: • clearly state your own perspective on the issue and analyze the relationship between your perspective and at least one other perspective • develop and support your ideas with specific evidence, reasoning and examples • organize your ideas clearly and logically • communicate your ideas effectively in standard written English Your perspective may be in full or partial agreement with any of those given, or completely different.		

Planning Your Essay

Use the [essay-planning sheet](#) to generate ideas and plan your essay. **THIS WILL BE GRADED.** Consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

Source: “Wolf Hunting Guide.” Montana Fish, Wildlife and Parks. *State of Montana*. Accessed 25 Oct. 2017

Ecology Prompt 2: Mussel Invasion!

Zebra and quagga mussels are freshwater mollusks that colonize lakes and rivers. Their preferred habitats include the calm waters upstream of dams. These species could cost taxpayers hundreds of millions of dollars a year and close down access to state waters for recreation and commercial opportunities. They clog water intake pipes and filters, reducing water-pumping capabilities for power and water treatment plants. Once established, these mussels will change ecosystems and food sources critical to native mussels and species such as salmon and trout. Tests published in November 2016 showed baby mussels, called veligers, present in the Tiber Reservoir North of Great Falls and possibly in Canyon Ferry near Helena.

In response, Montana organized education and inspection efforts to prevent the spread of these mussels. All watercraft were expected to stop at watercraft inspection stations along the highways this summer. Sportsmen can be charged with a felony and fined up to \$5000 if they knowingly or purposely attempt to introduce AIS into Montana waters and can be cited for driving past an inspections station without stopping. The inspection stations closed for the season on October 15th, but all water users are asked to voluntarily “Clean, Drain, and Dry” boats and equipment before using them in Montana waters.

A program initiated by bill from the 2017 Montana Legislature will provide significant funding for the state's fight against aquatic invasive species. The Aquatic Invasive Species Prevention Pass is now required for all anglers at a cost of \$2 for residents and \$15 for nonresidents. The passes are estimated to generate \$3.2 million. Other states require an additional fee for an AIS boat sticker you have to purchase before launching your boat, but this does not currently exist in Montana. **Knowing the impact mussels have had on other waterways in the U.S., what is your opinion about the current and future management of this species?**

Read and carefully consider these perspectives. Each suggests a particular way of thinking about the issue of invasive mussel management.

Perspective One	Perspective Two	Perspective Three
Mussels have not yet been confirmed in the Helena-area waterways which means our efforts to stop them are working. Increased inspections and education efforts are an unnecessary expense and boaters and anglers should not be expected to pay fees to fund them.	Mussels are effectively controlled now, but threats will continue to increase as their populations grow in nearby states. Montana should continue the inspection and education programs in place and keep the prevention pass fees to pay for them.	Mussels will destroy our waterways and must be stopped at all cost. The state should increase fees and use funds for more inspection stations and additional education of boaters and anglers.
Essay Task Write a unified, coherent essay about the issue of invasive mussel management. In your essay, be sure to: • clearly state your own perspective on the issue and analyze the relationship between your perspective and at least one other perspective • develop and support your ideas with specific evidence, reasoning and examples • organize your ideas clearly and logically • communicate your ideas effectively in standard written English Your perspective may be in full or partial agreement with any of those given, or completely different.		

Planning Your Essay

Use the [essay-planning sheet](#) to generate ideas and plan your essay. **THIS WILL BE GRADED.** Consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

Source: "Aquatic Invasive Mussels." Montana Fish, Wildlife and Parks. *State of Montana*. Accessed 25 Oct. 2017.

Ecology Prompt 3: WILDFIRE!

The 2017 fire season in Montana was one of the worst on record. By July there were 21 large, active fires that had consumed over 438,000 acres. By September 20, after rain and snow had significantly slowed most fire growth, the overall burned acreage in Montana was estimated at 1,295,959 acres. A number of areas were evacuated, including most of the town of Seeley Lake, and many homes, structures and grazing lands were lost. Over \$280 million was spent fighting fires; about \$53 million of that came directly from the state budget, leaving schools and state agencies grossly underfunded. More than 4,000 firefighters battled against the fires and two of them lost their lives fighting fires in western Montana.

The fire season began a month earlier than usual. The months of June through August were the hottest and driest on record for Montana. On July 29, Montana had 11.87 percent of its total land listed as in exceptional drought, the largest percentage in the nation. According to experts on climate change, wildfires and drought will continue as long as atmospheric CO₂ levels rise. The Union of Concerned Scientists projects that wildfire seasons in the United States will lengthen into the fall and winter months and “megafires” are likely to be more common and more severe. Surprisingly, some dry grassland areas may be less at risk, but not because they would be flourishing—the intense aridity is likely to prevent these grasses from growing at all, leaving these areas so barren that they are likely to lack even the fodder for wildfire.

Knowing the impacts climate change are projected to have on our forests and grasslands, what is your opinion about the current and future management of wildfires?

Read and carefully consider these perspectives. Each suggests a particular way of thinking about the issue of wildfire management.

Perspective One	Perspective Two	Perspective Three
Current wildfire management efforts are working. Although climate change will make the fires more severe, the management techniques we have in place are adequate and do not need to be changed.	Wildfires are a natural successional event in our western forests and grasslands. Although climate change is increasing the size and severity of these fires, there are many solutions to protect homes and health while keeping many of our current management plans in place.	We must take action. By clearing buffer zones between homes and susceptible forests and by taking steps to reduce our impact on the climate, we can reduce the severity of megafires. Increased education and spending on fire mitigation is needed now.

Essay Task

Write a unified, coherent essay about the issue of wildfire management. In your essay, be sure to:

- clearly state your own perspective on the issue and analyze the relationship between your perspective and at least one other perspective
- develop and support your ideas with specific evidence, reasoning and examples
- organize your ideas clearly and logically
- communicate your ideas effectively in standard written English

Your perspective may be in full or partial agreement with any of those given, or completely different.

Planning Your Essay

Use the essay-planning sheet to generate ideas and plan your essay. **THIS WILL BE GRADED.**

Consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

Ecology Argumentative Paper Grading Chart Name _____ Period _____

TITLE:		
<u>Introduction Paragraph</u>	Student Check	Teacher Grade
Hook--interesting related fact, quote or conflict statement introducing the topic		
Background information of the topic (5 relevant facts explained, cited)		
Two or more conflicting perspective on the topic presented		
Strong statement of Thesis—what is your perspective on this topic?		
Comments:		

<u>Body Paragraph 1</u>		
Presents perspective #1 on topic		
2 or more pro statements supporting the perspective		
Evidence and facts used and properly cited		
Comments:		
<u>Body Paragraph 2</u>		
Presents perspective #2 on topic		
2 or more pro statements supporting the perspective		
Evidence and facts used and properly cited		
Comments:		
<u>Body Paragraph 3</u>		
Presents problems with perspective #2 on topic		
2 or more negative statements supporting the perspective		
Evidence and facts used and properly cited		
Comments:		
<u>Conclusion Paragraph</u>		
Begins with a sentence restating the thesis in different words		
Restates the two perspectives, showing why each is important		
States why your chosen perspective is the most logical choice-support w/evidence		
Why is this topic important, so what? Consider policy, regulations, quality of life, etc		
Comments:		
OVERALL WRITING SKILLS		

Organization --logical, like ideas are together and linked with transitions		
Development and Support --Evidence used to support arguments is logical		
Ideas and Analysis —Thesis clearly states a position and addresses at least one other		
Analysis is complete, accurate, examines complexities, addresses existing values		
Language Use --vocabulary is appropriate and enhances understanding of topic		
Sentence structure, grammar, and language mechanics are used properly		
Citations —Paraphrasing, not copying, unless a SHORT direct quote (no plagiarism)		
2 or more sources are properly cited at the end of the paper in works cited section		
In-text citations are present and properly done throughout the paper		
Comments:		

Spring 2018 DWA Prompt: Distracted Driving

Distracted driving is in the news as more and more people multitask while behind the wheel. According to the Centers for Disease Control and Prevention (CDC), each day 9 people are killed and over 1000 are injured in distracted driving accidents. The CDC defines distracted driving as anything that removes a driver's attention from the road. Common distractions are eating and drinking, but a big one is electronics, including cell phones. To deal with the issue of electronic distractions, in 2017 the state of Washington passed a law called Driving Under the Influence of Electronics (DUIE). This law raises the fines for electronic distractions while driving. Currently in the state of Montana, a first offense Driving Under the Influence of alcohol or drugs (DUI) results in a \$600 fine. A speeding citation, on the other hand, can cost as little as \$20. Should distracted driving be treated with severe penalties like driving under the influence of drugs or alcohol? Given the implications of distracted driving, it is worth examining how it should be dealt with by law enforcement.

Read and carefully consider these perspectives. Each suggests a particular way of addressing the problem of distracted driving.

Perspective One	Perspective Two	Perspective Three
Distracted driving should be treated severely, similar to driving under the influence of drugs or alcohol. All states should follow Washington and create a distracted driving law with harsh punishments.	Law enforcement should not have the power to issue citations specifically for distracted driving. It can be difficult, if not impossible, to prove if a driver was distracted at the time of an accident. The citation a person will receive for causing an accident is enough to ward off future incidents of distracted driving.	Distracted driving should be cited by law enforcement, but not as severely as driving under the influence of drugs or alcohol. Fines should be issued for distracted driving.

Essay Task

Write a unified, coherent essay addressing the problem of distracted driving. In your essay, be sure to:

- clearly state your own perspective on the issue and analyze the relationship between your perspective and at least one other perspective
- develop and support your ideas with reasoning and examples
- organize your ideas clearly and logically
- communicate your ideas effectively in standard written English

Your perspective may be in full agreement with any of those given, in partial agreement, or completely different.

Planning Your Essay

Your prewriting work will not be scored. Use the back of this sheet to generate ideas and plan your essay. You may wish to consider the following as you think critically about the task:

Strengths and weaknesses of different perspectives on the issue

- What insights do they offer, and what do they fail to consider?
- Why might they be persuasive to others, or why might they fail to persuade?

Your own knowledge, experience, and values

- What is your perspective on this issue, and what are its strengths and weaknesses?
- How will you support your perspective in your essay?

“Distracted Driving.” *Centers for Disease Control and Prevention*, 9 June 2017,
www.cdc.gov/motorvehiclesafety/distracted_driving/index.html

“Driving Under the Influence Penalties.” *Montana Department of Justice*, June 2017,
www.mdt.mt.gov/visionzero/docs/dui_penalties.pdf

APPENDIX B

CLOSE READ DOCUMENTS

Close Reading Strategy for Students

--Format developed by Kate Peterson, Helena High School Library

A close reading requires several steps and should be tackled with concentration and deliberate effort. This process will ask you to re-read a document several different times and focus on one specific aspect of understanding each time. Staying true to the steps and the process will assist you at getting to the depth of meaning necessary for a close reading.

1st Read--Investigate

1. Read through the document once. Pay attention to the title, headings, and graphics.
2. Note the organization of the document in order to determine how the information is presented to the reader.
For example: Does the document begin with an appeal to emotion then present the facts? Does the document present general information then move to more specific? Does the document present an argument and build evidence to support a claim?
3. Check the document for currency and reliability and consider the audience for whom it is written.
Note: What is the publication date? How may this date affect the author's intentions? Who is the author? Is the author associated with any groups or individuals that may create bias? What audience does the author have in mind?
4. Annotate the document, addressing the following features:
 - a. Circle key vocabulary and define any unfamiliar vocabulary
 - b. Underline key ideas
 - c. Put a + or a – next to each paragraph to indicate your understanding
 - d. Record any questions or reactions you have at this point (minimum of ____).

2nd Read--Formulate

5. Read the document a second time. While you read, revisit your annotations, paying particular attention to the key ideas you have underlined. Answer any questions from your annotations and check understanding, paying close attention to the information previously noted as unclear.
6. Define the teacher-selected vocabulary.
7. In one or two sentences, record the main idea of the document.

3rd Read--Analyze

8. Read the document a third time. Answer text-dependent questions.
9. After re-reading your annotations, write a reflection, considering how your understanding has changed and what part of the Close Reading process helped get you there.

As a culminating activity, consider writing a summary or participating in a class discussion to achieve the following goals:

- use specific evidence from the text to evaluate the author's message
- draw inferences
- reach a conclusion

Close Reading Student Handout

Developed by Helena School District High School Libraries – Application of Close Reading

MLA Citation of Article:

1st Read—Investigate: Read the document once. Pay attention to the title, headings, and graphics.

When was this published? Is that publication's date important in relation to the information being shared? Note the author. Note the potential for bias. For whom was the document written?

Annotate the document by:

- i. Circle key vocabulary and underline key ideas. Define any unfamiliar vocabulary.
- ii. Underline key ideas.
- iii. Put a + or – next to each paragraph to indicate your understanding.
- iv. Record any questions or reactions you have at this point (minimum of ____).

Organization of the document:

2nd Read—Formulate: Read the document again. While you read, revisit your annotations, paying particular attention to the key ideas you have underlined. Answer any questions from your annotations and check understanding, paying close attention to the information previously noted as unclear.

Define the teacher-selected vocabulary.

_____ → _____

_____ → _____

_____ → _____

_____ → _____

In one or two sentences, record the main idea of the document.

3rd Read—Analyze: Read the document a third time and answer the text-dependent questions in complete sentences.

1. _____

2. _____

3. _____

4. _____

5. _____

After re-reading your annotations, write a reflection, considering how your understanding has changed and what part of the Close Reading process helped you get there.

Summary:

[illegible]

In your summary, consider the document as a whole. Include the following ideas, IN YOUR OWN WORDS:

- *The key ideas*
- *Evidence that supports the ideas*
- *Important ideas/facts that are missing from the document*
- *Inferences drawn from the document*
- *Significance of the information and/or document*

* Remember to remain faithful to the author's original intent but avoid plagiarism by changing the sentence structure and vocabulary.

Close Read Worksheet for “Weighing in on Wolves” by Tom Dickinson, *Montana Outdoors*. MT FWP, March/April 2014.

Name: _____ Per: ____ Date: _____

1st Read—Investigate: Follow the directions on your **yellow close read sheet** to read and annotate the article.

Answer **question 3** here: Publication date: _____ Author’s intentions? _____

Author’s name: _____ Association

Possible biases?

Intended audience?

2nd Read—Formulate and Analyze:

1. Answer questions from your annotations. Search online for more information if necessary.

2. Record the main idea in 1-2 sentences.

3. Notes on the organization of the document:

4. Text-dependent questions:

- a. What did you know about this topic before you read the article?
- b. What new information did you learn?
- c. What **facts** (look for numbers and specific evidence) support increased hunting and trapping of wolves?
- d. What **opinions** do the people interviewed have about hunting and trapping wolves?
- e. What **facts** (look for numbers and specific evidence) support the continued protection of wolves?
- f. What **opinions** do the people interviewed have about protecting wolves?
- g. What is your opinion about this topic? Explain and use specific evidence to support.

Final reflection: On the back of this paper, write a paragraph about this topic. How did your understanding of this topic change? What parts of the close reading strategy helped you? **Include ideas you will use in our class discussion.**

“Weighing in on Wolves” by Tom Dickinson, *Montana Outdoors*. MT FWP, March/April 2014.

DRIVING THROUGH THE FROZEN landscape of Yellowstone National Park’s (YNP) Lamar Valley one recent morning, wolf watching guide Nathan Varley slows down and points to several ravens about a mile off. “There it is,” he says, pulling over to set up his spotting scope and train it on a recent elk kill, which a few minutes earlier a colleague had told him was in the vicinity. For an hour we watch two wolves feeding on the carcass, a large gray male known to local watchers as “Crooked Ear” and a smaller black female called “Spitfire.” The naming fosters anthropomorphizing, admits Varley, but it helps with identification, as do numbers given to about 20 percent of the park’s wolves that wear radio collars for research purposes. Several other wolf watchers gather along the road in the bitter cold to view the large carnivores, clearly visible through high-powered optics. Crowded tour buses and minivans operated by wildlife-viewing companies pass by every 15 minutes or so, returning to Gardiner from another elk kill farther up the valley.

Varley, who lives in Gardiner, studied the park’s carnivores for several years while earning a doctorate in ecology. But his primary concern with wolves these days is economic, not academic. “Every park wolf that steps over the border into Montana and Wyoming and gets shot is money out of our pocket,” says the wildlife guide, who is also vice president of a local group called Bear Creek Council that tries to increase tolerance for wolves and bison leaving the park. Varley and his wife run Yellowstone Wolf Tracker wildlife tours, one of a dozen or so guiding operations sanctioned by park officials. These kinds of services are at the heart of a thriving wolf watching tourism that a University of Montana study found pumps millions of dollars into counties surrounding the park each year. That economic argument is just one used by wolf advocates critical of growing hunter and trapper wolf harvests in Montana, Idaho, and Wyoming. Some are like Varley, who has no gripe with wolf hunting elsewhere but wants a kill-free buffer around Yellowstone.

Others, often from outside the Rocky Mountain West, want to halt all lethal action on an animal that was classified as federally endangered just a few years ago. On the flip side are those who demand that Montana kill more wolves, which they say harm ranchers’ bottom line and deplete elk and deer herds. “We’d like the state to take much more aggressive measures in certain areas to bring these predator numbers down to a more tolerable ratio with prey populations,” says Rob Arnaud, president of the Montana Outfitters and Guides Association. “We’ve got hunting outfitters around Yellowstone going out of business because of wolves.” Montana Fish, Wildlife & Parks is listening to all sides. The department’s job is to ensure there are enough wolves to maintain a healthy population in Montana, as mandated by its mission and federal law.

At the same time, it works to limit livestock depredation, maintain abundant deer and elk, and foster public tolerance for wolves. It’s a balancing act, and, with impassioned interests tugging every which way, not an easy one.

The wolf has long represented conflicting views of untamed nature. Roman, Norse, and Celtic mythology celebrated wolves, yet the carnivores were feared and persecuted throughout Europe for centuries. Native American tribes revered wolves as guides to the spirit world. The United States nearly eradicated the carnivore with bounties and, later, wide-scale federal government extermination. In Montana alone, “wolfers” killed 100,000 wolves between the 1860s and 1920s, primarily with poison. Public attitudes toward wolves began to change in the 1970s as part of the growing environmental movement. *Canis Lupus*, nearly extinct in the Lower 48, became a symbol of the nation’s vanishing wildness. In 1995, 66 wolves were live-trapped in Canada and set free in Yellowstone National Park and the wilderness of central Idaho. Their goal: Restore wolves to a region where they had almost been eliminated. Western states objected but took some comfort knowing that management authority, which includes regulated hunting and trapping, would revert back to them once the wolf population reached federal recovery goals.

In the first decade after the Yellowstone introduction, the highly prolific carnivores grew rapidly in number and range. By 2001 the regionwide population count surpassed the federal goal of 300 in Idaho, Montana, and Wyoming combined (at least 100 in each of the three states). By 2007 it reached at least 1,500—five times the initial target. Yet as wolf advocates cheered the growth, stockgrowers were reporting more and more livestock losses. Hunters in some areas began seeing fewer deer and elk and attributed the disappearance to growing wolf numbers. With the large carnivores still under federal protection, wolf critics felt powerless to stem the rapid population growth. They grew increasingly vocal, holding rallies, proposing legislation to defy federal rule, and even threatening illegal actions. “Shoot, Shovel, and Shut Up,” read one popular bumper sticker. Anti-wolf furor lessened after 2011, when the U.S. Fish & Wildlife Service (USFWS) removed (“delisted”) the Northern Rockies population from the federally threatened and endangered species list. Wolves could now be hunted under carefully regulated conditions. Still, many wolf opponents complained that too many wolves remained in areas where hunters were unable to reduce numbers. Demands grew for the state to kill pups in dens, or, as Alaska and Idaho do, employ aerial gunning from helicopters.

Such radical proposals alarmed wolf advocates. With the species no longer under federal protection but instead subject to state control, they responded by ramping up their rhetoric and protests, just as wolf critics had a few years before. Public comments to FWP skyrocketed, from 500 on the first proposed wolf hunting season to more than 25,000 on the most recent. Most were coordinated e-mail “blasts” coming from outside Montana that denounced all wolf hunting. ^u Outrage over killings Much of the outcry from wolf advocates concerns the Yellowstone park wolves. Extensive coverage by the BBC, National Geographic, The New York Times, and other global media have detailed the carnivores’ complex social interactions since reintroduction. Fans throughout the world track the Junction Butte, Blacktail and other packs on blog posts and Facebook pages maintained by watchers who cruise the park’s roads year round. Devotees can see where Tall Gray was spotted last week or learn how 686F is fairing in Mollie’s Pack, as though the wolves were characters in a reality TV show. Little wonder the Internet lit up this past August after a collared YNP wolf (820F) that had become habituated to humans was killed in Gardiner. “People become attached to these wolves that then leave the park and are shot. They get outraged,” says Varley.

Yellowstone's wolf population has declined in recent years, not due to outside-the-park hunting, as some suggest, but mainly from a shrinking elk population. (All hunting is banned within the borders of national parks.) In the late 1980s and early '90s, the northern Yellowstone elk herd was one of the nation's largest. Reintroduced to this prey-rich environment, wolves grew from 41 in 1997 to a peak of 174 in 2003. As park biologists predicted, once elk numbers dropped (due to predation, weather, and liberal elk hunting seasons outside the park) so did the wolf population, which now numbers 86. Hunters have legally killed wolves that wander out of Yellowstone, but far more of the animals have died from wolf-on-wolf attacks, starvation, and disease. Mange alone has killed dozens.

Though the park's wolf decline understandably concerns watchers and guides, "the Yellowstone introduction was not designed to create wolf viewing opportunities or businesses," says Ken McDonald, head of FWP Wildlife Division. "It was meant as the base for expansion far beyond the park's perimeter. Park visitors focus on individual animals, but here in Montana our responsibility is to manage wolves at a population level." Wolf numbers in Montana and elsewhere in the Northern Rockies are robust, making the park's pack less significant to the regional population than their popularity would indicate, says McDonald. Today just over 5 percent of the 1,600-plus wolves in the Northern Rockies reside in Yellowstone. The species is thriving across the West and Midwest, despite recent claims by the Sierra Club that hunting "has driven the gray wolf nearly to extinction." According to the U.S. Fish & Wildlife Service, the Lower 48's wolf population has grown by 50 percent over the past decade to 5,360. Outlandish claims show up on both sides of the issue.

Some wolf critics still insist the carnivores are "wiping out" most of western Montana's elk populations. True, numbers are considerably down in some areas that have especially high wolf densities, notably the upper Gallatin, Blackfoot Valley, and Gardiner areas. But elk numbers remain at or above "population objectives" (what the habitat base and land owners will tolerate) in 81 percent of the state's hunting districts. MARCH-APRIL 2014

FWP.MT.GOV/MTOUTDOORS MONTANA OUTDOORS ▾ Addressing reasonable concerns
Exaggerations aside, most apprehension over wolves is well within reason: A Dillon rancher needs to protect his sheep; a Missoula hunter wants to see elk next November; a Bozeman naturalist desires to live in a state with a healthy wolf population; a Florida tourist hopes her favorite Yellowstone wolf stays free from harm. "We take all reasonable concerns about wolves seriously," says Jeff Hagener, FWP director. The department notes that livestock losses declined last year thanks to higher hunting and trapping harvest. Also credited are ranchers working with the department's six wolf specialists to protect sheep and cattle using fence flagging (flagging), carcass removal, and other measures. Following reports of wolf predation on the southern Bitterroot Valley's elk herd, the department launched a large-scale investigation in 2011.

Researchers recently found that mountain lions are more responsible for elk population declines there than wolves are. What's more, the southern Bitterroot elk herd is rebounding, likely thanks to favorable weather and habitat conditions. As for criticism that Montana hasn't done enough to control wolf numbers, "FWP fought for years to restore state management authority that includes public hunting and trapping," says Hagener. Because wolves are wary and difficult to hunt or trap, FWP has supported liberalized regulations that now include a six-month season, electronic calls, and a wolf limit of five (a number that very few hunters or trappers actually take).

Montana is working to pare down the population of 600-plus wolves living here. But the state will not drive numbers low enough to trigger federal re-listing under the Endangered Species Act (ESA). “We can keep the ESA at bay only if we continue to show we have adequate regulatory mechanisms in place and are not advocating wholesale wolf slaughter,” says McDonald. In support of wolves, Montana’s wolf conservation plan—the document that guides its wolf management—recognizes that many people value wolves, the large carnivores play an important ecological role, and the population must remain genetically connected to those in other states and Canada if it is to survive over time. FWP opposes poison, aerial gunning, and proposed legislation classifying wolves as predators that can be shot on sight. The department has created special hunting zones around YNP and Glacier National Park that reduce the chances that a park research wolf will be killed, and it urges hunters not to shoot radiocollared wolves. FWP has also committed to keeping the population well above what the USFWS originally deemed sufficient for recovery. Despite protests from wolf advocates, Montana will continue to allow hunters and trappers to kill wolves. That was part of the recovery agreement. Paradoxically, it’s also in the wolf’s best long-term interests. “As hard as it might be for some people to believe, allowing Montanans to hunt wolves actually builds tolerance for wolves,” says Hagener. He points out that overall anti-wolf anger in Montana, though still strong in some circles, has eased considerably since hunting and trapping seasons began in 2011. “As long as we can manage wolf numbers at what most Montanans consider an acceptable level, people here will accept having a certain amount of wolves on the landscape along with some loss of livestock and prey animals.” But without regulated harvest, Hagener says, “there’d be much more pressure to treat wolves like varmints that could be shot anytime, year-round.” Such relentless mortality would drive down Montana’s overall wolf population. And it would prevent Yellowstone wolves from moving freely across the region to breed with counterparts in Idaho and northern Montana, threatening that population’s genetic health and future survival.

Most people, including Montanans, want wolves to exist in the Northern Rockies. But how many, and where? It should come as no surprise that what is considered “enough” differs widely between those trying to live their lives on a landscape where wolves live, too, and those watching the drama play out from hundreds of miles away.

Close Read Worksheet for “How Megafires are Remaking American Forests” by Laura Parker, *Nat.Geo.* 2015

Name: _____ Per: ____ Date: _____

1st Read—Investigate: Follow the directions on your **yellow close read sheet** to read and annotate the article.

Answer **question 3** here: Publication date: _____ Author’s intentions? _____

Author’s name: _____ Association _____

Possible biases? _____

Intended audience? _____

Vocabulary List (look up definitions for at least 2 words):

2nd Read—Formulate and Analyze:

1. Answer questions from your annotations. Search online for more information if necessary.
2. Record the main idea in 1-2 sentences.
3. Notes on the organization of the document:

4. Text-dependent questions:

- a. What did you know about this topic before you read the article?
- b. What new information did you learn?
- c. What **facts** (look for numbers and specific evidence) support the opinion that fire is harmful?
- d. What **facts** (look for numbers and specific evidence) support the opinion that fire can be helpful?
- e. What **opinions** do the people interviewed have about fires?
- f. What is YOUR opinion about this topic? Explain and use specific evidence to support.

Final reflection: On the back of this paper, write a paragraph about this topic. How did your understanding of this topic change? What parts of the close reading strategy helped you? **Include ideas you will use in our class discussion.**

How Megafires Are Remaking American Forests

Supersize fires are burning up bird habitat, killing trees, and turning forests into open range. Climate change will only make it worse.

By Laura Parker, National Geographic

PUBLISHED AUGUST 9, 2015

TWISP, WASHINGTON The largest fire in state history swept through the eastern slopes of the Cascade Range with explosive force last summer. The Carlton Complex Fire burned more than 250,000 acres, devouring everything in its path at the hypersonic pace of 3.8 acres per second.

Until then, the top slot in the state's fire rankings belonged to the Tripod Fire, which burned up 175,000 beetle-infested acres in two months on the same slopes in 2006.

Carlton and Tripod are "megafires," part of a wave of extreme fires that are transforming the great forests of the American West. By the end of the century, scientists say, megafires—

conflagrations that chew up at least 100,000 acres of land—will become the norm. Which makes them of critical interest to researchers.

These infernos, once rare, are growing to sizes that U.S. Forest Service Chief Tom Tidwell describes as “unimaginable” two decades ago. Five alone have consumed more than five million acres in central Alaska since June. Washington, Oregon, California, Arizona, New Mexico and Colorado also experienced their worst wildfires in the past seven years.

So far in the Lower 48, only one of the thousands of fires that have burned across the 11 Western states have grown into megafire size. The Soda Fire, which broke out Aug. 10 in southwest Idaho has burned more than 119,000 acres and crossed into Oregon. And, the most perilous weeks of fire season are still ahead. With extreme drought and sizzling temperatures searing the West, the only remaining component needed to turn low-threat fires into catastrophic ones is gusting wind. The Carlton Complex Fire, propelled by 30 mph gusts, took just one day to reach that status.

Megafires are remaking forests in ways that scientists are still struggling to understand. They incinerate habitat for songbirds like the yellow-rumped warbler, push already-vulnerable whitebark pine trees closer to extinction, and, when they are especially ferocious, burn down whole forests so thoroughly, they never grow back.

Superimpose an outline of the devastated acreage of the Carlton Complex and Tripod Fires on a map of the Okanogan National Forest and the extent of the damage comes into sharp focus. “You start to see these big burn patches,” says David Peterson, a Forest Service research biologist and University of Washington forestry professor.

“We are starting to see them in the Pacific Northwest—Idaho, Oregon and other places. These patches are going to start running into each other. This is what will change the landscape.”

A change, he might have added, that will be probably be irrevocable.

“When fires are really large and severe and most of the trees burn up, it’s very difficult for a seed source to survive,” says Paul Hessburg, a Forest Service plant pathologist in Wenatchee, Washington. “Trees can take a century to regenerate. Meanwhile, fires will reoccur and keep those areas stuck in grass and shrub.”

What’s turning small fires into raging infernos is a stew of ingredients that includes government fire-fighting policies and the continued push by millions of people to set up housekeeping on the edge of national forests.

But the main driver is climate change. Rising temperatures exacerbate drought, spread beetle infestations and melt the snowpack earlier. Early snowmelt alone has lengthened the fire season by 70 days since 1970.

“These stresses are going to become more widespread,” says Craig Allen, a U.S. Geological Service forest ecologist in Los Alamos, New Mexico. “The drought itself is part of the natural variability here. What’s different is it’s a hotter drought than anything in the Northern Hemisphere in the last thousand years.”

A NATURAL HISTORY OF FIRE

Fire is part of the natural forest lifecycle. It thins trees, helps new seedlings take root, and removes decaying debris that has the potential to become tinder. So trees are well-adapted to flames. Ponderosa pines shed lower limbs and wear bark so thick they're literally fire proof. In the Southwest, scientists have discovered pine tree rings bearing scars of more than 30 individual fires they survived.

Over the decades, a subtle shift began to occur. Fires began to grow in size and trees took longer to regenerate.

The event that signaled the advent of megafires occurred in 1988, when fires in Yellowstone National Park caused by an unusually dry season burned 1.2 million acres—about 36 percent of the park.

Yellowstone recovered, but in the decades since, the number of big fires steadily multiplied. Today, wildfires, on average, burn twice as much land every year now as they did 40 years ago, according to an analysis of 42 years of U.S. Forest Service records, by Climate Central, a nonprofit research group. There have been an average ten megafires a year in the past ten years, according to statistics kept by the National Interagency Fire Center in Boise, Idaho.

The trend will only build as the planet warms. The National Research Council estimates that the amount of land burned in the West will quadruple for every degree Celsius (1.8 degrees Fahrenheit) that temperatures rise. According to government predictions, summer temperatures in the West will increase by 3.6-to-9 degrees Fahrenheit by mid-century.

TO FIGHT OR NOT TO FIGHT

Ironically, the century-old government policy of fighting fires instead of letting them burn has led to a build-up of the very tinder that lesser fires once destroyed as part of the natural process.

"It's a bit of magical thinking that if you keep putting fires out, fires will go away," Hessburg says. "What happens is they get more severe, because you just keep loading a powder keg."

In New Mexico and Arizona, for example, where small fires were the norm, forest debris built up over decades finally touched off the Southwest's largest fires in the early 2000s.

So what to do about it? Clearing forests of excess vegetation through "managed burns," might improve the odds of keeping fires small. But there is little money to do so.

Tidwell told Congress 58 million acres of national forests are at risk for severe fire, but there is only enough funding to clean up 11.3 million acres; priority goes to areas where housing development pushes against wilderness. (Between 1940 and 2000, the number of houses within a half-mile of a national forest rose from 484,000 to 1.8 million, according to Forest Service figures.)

OWLS LOSE, WOODPECKERS WIN

Meanwhile, scientists are still sorting out what Western forests might look like in the next century. Uncertainties remain. How much change in climate can forests tolerate before reaching a tipping point?

“We think forests can hang on for a long time when the climate has slipped out from under them,” says Steve Running, a University of Montana fire ecologist. “What wipes the slate clean is fire.”

Forests of the future, growing in hotter, drier environs, will be sparser, with fewer trees per acre, and fewer small trees in the understory. They will also be younger, as fire “resets” forest age. In cases where forests cannot recover, the land may give way to open range, with grass and shrub.

“We will see a reduction in the total area of forest and changes in distributions of tree species,” says Monica Turner, a University of Wisconsin ecologist who has tracked Yellowstone’s changes since the fire. “So it is critical that we keep an eye on places like Yellowstone which will be key to our ability to see how species adapt.”

There will be clear winners and losers in what Peterson calls “a re-arrangement” of species. Spotted owls, which nest in old-growth forests, are high on the list of losers, if events like the 500,068-acre Biscuit Fire that destroyed their habitat in the Siskiyou National Forest in southern Oregon and northern California in 2002, are good predictors. That’s just one of many large fires that have already forced owls to relocate.

Woodpeckers are among the winners, along with small hawks and other birds that like to call bug-filled, hollowed out dead trees home. Deer and elk prefer open spaces created when forests burn down, but denuded terrain also attracts invasive plants, which crowd out native species. One of the most notorious of these is cheat grass.

Southern Idaho, where much of the forest has burned in the last quarter-century, has seen a dramatic transformation from forest to open range.

“We’re seeing the migration of the Great Plains ecosystems northward into Idaho now,” says Dick Bahr, deputy director of the Interior Department’s wildlands fire office. “People are going, ‘whoa, what happened?’”

Rocky Barker, an Idaho journalist and author of *Scorched Earth: How the Fires of Yellowstone Changed America*, says a scientist friend once advised to him to move north.

“He told me if I liked my life in Boise, I might think about moving to Coeur d’Alene because Idaho forests are going to follow in the same direction.”

AFTERMATH OF A FIRE

It is too early by decades to assess the impact of the Carlton Complex Fire. But based on recent patterns, Bahr and others think its stately stands of Ponderosa may be gone for good.

The Carlton Complex began as four lightning-sparked fires last July 14 that coalesced into one. The blaze roared out of the mountains and across the shrub steppe to the Columbia River, burning through 123,000 acres – half the territory it would claim – in nine hours. The fire didn’t kill anyone, but destroyed 300 homes.

Carlene Anders, who has fought hundreds of fires in her 30 year-long career, has never seen anything like it.

"It was like a tidal wave," she says. "There were fires within fires."

In spring, the shrubs and bitter bush greened up. Kayakers and cyclists came back to celebrate the Methow Valley's rebirth. But high on hillsides, broad stands of charred Ponderosa pines are not far out of sight.

"That was the part of the fire that made me heartsick," says Susan Prichard, a University of Washington fire ecologist who is tracking the fire's aftermath. "Ponderosa pine is built to withstand fire. What we saw in Carlton was 100 percent mortality, even on open ground. The heat just made the trees succumb."

Laura Parker is a staff writer who specializes in covering climate change and marine environments.

Close Read Worksheet for "Destructive non-native mussel larvae discovered in Montana waters" by Karl Puckett, Great Falls Tribune. Published 2:49 p.m. MT Nov. 9, 2016 | Updated 5:30 p.m. MT Nov. 9, 2016

Name: _____ Per: ____ Date: _____

1st Read—Investigate: Follow the directions on your **yellow close read sheet** to read and annotate the article.

Answer **question 3** here: Publication date: _____ Author's intentions?

Author's name: _____ Association _____

Possible biases? _____

Intended audience? _____

Vocabulary list (define 2 words you highlighted):

2nd Read—Formulate and Analyze:

1. Answer questions from your annotations. Search online for more information if necessary.
2. Record the main idea in 1-2 sentences.
3. Notes on the organization of the document:
4. **Text-dependent questions:**
 - a. What did you know about this topic before you read the article?

- b. What new information did you learn?
- c. What **facts** (look for numbers and specific evidence) support the control of Aquatic Invasives?
- d. What **opinions** do the people interviewed have about Aquatic Invasives?
- e. What, specifically, are people doing to limit the spread of Aquatic Invasives? Who is in charge?
- f. What is your opinion about this topic? Explain and use specific evidence to support.

Final reflection: On the back of this paper, write a paragraph about this topic. How did your understanding of this topic change? What parts of the close reading strategy helped you? **Include ideas you will use in our class discussion.**

Destructive non-native mussel larvae discovered in Montana waters

Karl Puckett, kpuckett@greatfallstribune.com Published 2:49 p.m. MT Nov. 9, 2016 | **Updated 5:30 p.m. MT Nov. 9, 2016**

Tiber Reservoir east of Shelby has tested positive for the larvae of aquatic mussels, a tiny invasive species with a hard shell that can cause big impacts to boats, fish and water infrastructure such as hydroelectric dams.

Tests from Canyon Ferry Reservoir near Helena also show “suspect,” but inconclusive, results for mussel larvae, according to officials at Montana Fish, Wildlife and Parks.

It’s the first time the larvae of quagga or zebra mussels have turned up in Montana waters.

“It’s certainly a huge concern,” said Eileen Ryce, fisheries division administrator for Montana Fish, Wildlife and Parks. “Our priority is going to be containment and control. We’re currently looking at all sorts of options right now.”

The mussels, which can grow to inch and a half in size and live within two shells, are known for clogging pipes and other structures, interrupting the flow of water used for hydroelectric power, municipal use and agriculture.

Both mussel species are filter feeders and consume large portions of microscopic plants that small fish eat, and that affects larger fish such as walleye and trout that feed on the smaller fish, Ryce said.

We’re playing Russian roulette with aquatic mussel invaders.

Removal of the microscopic plants from the food web can cause a shift in the native species and disrupt the ecological balance of the water body, according to the state Department of Natural Resources and Conservation.

Many dead shells also pile up that can cut feet, besides being unsightly and smelly, Ryce added.

“There’s a couple of things in our favor right now,” Ryce said. “First of all we haven’t found any adults in Tiber or Canyon Ferry. The densities we’ve seen in both locations is very low. That indicates it’s probably a fairly new infestation.

“The other thing is we’re moving into winter so the water temperature is dropping, so they’re not going to be reproducing this time of year,” Ryce said.

FWP, along with other state and federal agencies and the Montana Invasive Species Advisory Council (MISAC), is now working to determine whether adult mussels are present in Tiber Reservoir and conducting further test results at Canyon Ferry, she said.

“It’s very serious,” said Stephanie Hester of the DNRC and MISAC coordinator.

Mussels can cause millions of dollars in economic and ecological damage, and she noted that a new water supply system is in the planning stages at Tiber, which already provides water for municipal, hydroelectric and agricultural uses.

Mussels, she said, out-compete native species.

“Basically, you end up with a clean, sterile lake,” she said.

The state, she said, needs to bulk up its water craft inspection stations. Currently, stations are open for eight hours a day certain times of the year. “There’s more we can do to bolster those efforts,” she said.

While larvae has been confirmed in Tiber, the initial positive tests in Canyon Ferry still need to be confirmed.

Up to 10 dogs will be mobilized to search for adult mussels at Tiber possibly as soon as next week, Hester said.

The dogs will come from the Flathead Basin Commission, which works to protect Flathead Lake in western Montana, and the provincial government in Alberta.

“They’re trained to find the adult mussels,” Hester said.

Both reservoirs are drawn down for the winter, and adults, if they grow, could dry out and freeze over the winter can kill them, Ryce added.

Tiber Reservoir, 20 miles southwest of Chester, is formed by a dam on the Marias River 90 miles north of Great Falls. It is an excellent year-round fishery for walleye, northern and sauger pike, and also has a privately owned hydroelectric facility.

“Obviously, that would be a concern at Tiber should they establish themselves as adults,” said Jack Conner, a public information officer for the U.S. Bureau of Reclamation.

Canyon Ferry Reservoir on the Missouri River, 20 miles east of Helena, offers excellent fishing opportunities for rainbow trout, perch, ling, and walleye. It also has a hydroelectric facility operated by the Bureau of Reclamation.

Mussels, which have byssal threads that attach to surfaces, grow on the outside or inside of boats, and can ruin motors and restrict cooling systems, according to the DNRC.

Mussels spread in moving water or by attaching themselves to boats, and it's likely that the microscopic larvae arrived at Canyon Ferry and Tiber on a boat from out of state, Ryce said.

A range of outcomes are possible, from no establishment of adult aquatic invasive mussels and no effects on lake/reservoir services, to full establishment and significant effects, according to the DNRC.

Other states have seen that range of impacts in water bodies with established quagga or zebra populations. .

FWP is going to look at setting up water craft inspection stations where boats can be decontaminated, Ryce said.

Options for chemically killing the mussels is limited because it can affect other species, Ryce said.

FWP and other entities have been actively monitoring for zebra and quagga mussels for over a decade.

Until 2016, neither zebra nor quagga mussels had been detected in Montana waters.

First notice of a suspect sample from Tiber Reservoir came from the U.S. Bureau of Reclamation on Oct. 17. A suspect Montana Fish, Wildlife and Parks sample from Canyon Ferry was found on October 28.

While the recent tests are bad news, they show the state's detection system is working, Ryce said.

Water samples from Fresno, Holter and Hauser reservoirs have come back negative, as did samples from Lake Frances, the Marias River and the Milk River.

Testing at Fort Peck Reservoir and the entire Missouri River system is ongoing.

The results from Tiber Reservoir show the larvae exist at very low densities, which improves chances for containment, Ryce said.

Bryce Christiaens, chair of the governor-appointed MISAC, emphasized the importance of all boaters and anglers to practice Montana's "Clean-Drain-Dry" protocol:

- ◆ Clean your boat and equipment every time you use it, especially if you move it to a new location.
- ◆ Drain all standing water, including any that may be left in the engine's cooling system, live wells and bilge areas.
- ◆ Dry everything that has come into contact with water.

Follow Karl Puckett on Twitter @GFTrib_KPuckett

What are zebra and quagga mussels?

Quagga mussels and zebra mussels are nonnative freshwater mussels that have invaded North American waters. Both species can grow to about an inch in diameter. Their infant stage is microscopic. Adults live for 3-5 years and can release 30,000-40,000 fertilized eggs in a single breeding cycle. Potential for spread is high once introduced even if it doesn't seem like there are many now.

Where did they come from?

Quagga mussels are native to the Ukraine and zebra mussels are native to the Caspian, Black and Azov seas of Eastern Europe. Both species were discovered in the Great Lakes in the late 1980's. It is believed they arrived in North America via ballast water discharge releasing their microscopic larval stage. From the Great Lakes, these mussels move overland primarily through human related activities.

What impacts will zebra and quagga mussels have on Montana?

Ecological Damage: Both species of mussels consume large portions of the microscopic plants and animals that make up the base of the aquatic food web.

Economic Damage: In the United States, congressional researchers estimated that zebra mussels alone cost the power industry \$3.1 billion in the 1993-1999 period, with their impact on industries, businesses, and communities more than \$5 billion.

Damage to recreational equipment: If adults attach and grow on the outside or inside of boats, they can ruin motors and restrict cooling systems, increase drag on the bottom of your boat, reducing speed and wasting fuel, jam steering equipment, and require scraping and repainting of boat bottoms.

APPENDIX C
LIKERT SURVEYS

General Likert survey (pre-and post-survey)

This is survey about your general attitude toward science, reading, writing and the argumentative essay. Please answer honestly and anonymously!

Circle the number that best describes your feelings about the close reading process.

1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

1. I enjoy science classes.

1 2 3 4 5

2. My friends like science.

1 2 3 4 5

3. Our classroom is safe and comfortable.

1 2 3 4 5

4. I always try to do my best in school.

1 2 3 4 5

5. We learn about important things in science class.

1 2 3 4 5

6. We do a lot of fun activities in science class.

1 2 3 4 5

7. I am comfortable designing and running experiments.

1 2 3 4 5

8. I like to collect data.

1 2 3 4 5

9. Data is useful when I am trying to support an argument with evidence.

1 2 3 4 5

10. I am comfortable using data as evidence to support an argument.

1 2 3 4 5

11. I would like to be a scientist.

1 2 3 4 5

12. I like reading about science topics.

1 2 3 4 5

13. I like writing about science topics.

1 2 3 4 5

14. I enjoy researching ideas online and finding reliable sources for information.

1 2 3 4 5

15. I am proud of my efforts on in-class writing assignments and the district writing assessment.

1 2 3 4 5

Modified Likert survey for close read and CER strategies (pre- and post-survey)

Please answer honestly and anonymously!

Circle the number that best describes your feelings about the close reading process.

1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

1. I like to read in my free time.

1 2 3 4 5

2. I sometimes find reading difficult—especially for science class.

1 2 3 4 5

3. I read news articles online or in magazines or newspapers.

1 2 3 4 5

4. Sometimes I read an article more than once to understand it.

1 2 3 4 5

5. I appreciate help with reading and annotating strategies.

1 2 3 4 5

6. I am already comfortable with reading and don't need help.

1 2 3 4 5

7. Sometimes I struggle to find the main idea in an article.

1 2 3 4 5

8. It is difficult to find evidence to support an author's claims.

1 2 3 4 5

9. New science vocabulary makes reading harder in biology class.
- 1 2 3 4 5
10. The close read strategy helped me understand the articles we read in this unit.
- 1 2 3 4 5
11. I am comfortable using data as evidence to support an argument.
- 1 2 3 4 5
12. Given any claim, I can research the topic and find evidence and reasoning to support it.
- 1 2 3 4 5
13. I know the difference between evidence and reasoning.
- 1 2 3 4 5
14. I am comfortable citing sources in MLA format without needing a resource guidebook.
- 1 2 3 4 5
15. I enjoy collecting data and using it to answer a question that intrigues me.
- 1 2 3 4 5

Short answer:

In **READ ONE** of the close read, which strategies did you think were useful?

Will you use these strategies again? _____ Where and how?

Which strategies were not useful?

Why?

In **READ TWO** of the close read, which strategies did you think were useful?

Will you use these strategies again? _____ Where and how?

Which strategies were not useful?

Why?

Please tell me anything else you want to share about the close reading strategy or the CER format in the space below.

APPENDIX D
CLAIM-EVIDENCE-REASONING TOOLS

CER Bell Ringers—Journaling Activity

The following “Bell Ringers” were used as formative assessments throughout the year to review material and test student ability to make a claim and support with specific evidence and reasoning. They were not graded, but the quality of answers was assessed using the CER rubric for the purposes of this investigation. Students were asked to follow the same format for each answer, but if they didn’t use the box diagram, answers were assessed on the content rather than use of the specific physical layout. Many of the prompts were modified from Page Keeley’s “Uncovering Student Ideas” series.

Q1: What makes something alive? Make a list of rules, then provide a sample species that illustrates each rule. Explain why it is necessary for all living things.

Q2: Choose from the list—which items are living? Which are non-living? Provide evidence and reasoning for two items (one you classified as living and one you classified as non-living).

Apple Egg Lettuce Bacteria Virus Cut Flowers Seed DNA Cell Soil

Q3: Which is more important to the health of a functioning ecosystem: a keystone species like a wolf, or a dominant species like a willow tree? Review your vocabulary and examples from yesterday, then make a claim and support with evidence and reasoning.

Q4: Claim: Humans are an invasive species. Support or refute this claim with evidence and reasoning.

Q5: Are there any cases where wildfires are good for an ecosystem? Make a claim and support with evidence and reasoning.

Q6: Should viruses be considered living? Why/why not? Support your claim with evidence and reasoning.

Q7: Claim: All bacteria are harmful. Support or refute this claim with evidence and reasoning.

Q8: Do bacteriophages help or harm humans? Make a claim and support with evidence and reasoning.

Q9: When are antibiotics most helpful, when treating a bacterial disease or when treating a viral disease? Make a claim and support with evidence and reasoning.

Q10: What is the most exciting potential use of bacteriophages? Make a claim and support with evidence and reasoning.

Q11: Claim: Gene therapy using viral vectors is a useful tool for curing genetic diseases and should be used more frequently. Support or refute this claim with evidence and reasoning.

CER Format

The Claim-Evidence-Reasoning format is used to help prove your arguments about what happened during your lab investigation. We tested a question and you collected data, but what do these data mean? Are your explanations supported by evidence and can you provide reasoning for the outcome?

Research Question:

1. Make a **Claim** based on your investigation. What was the answer to your question? Use vocabulary from our pre-lab reading or background research.

Example: *Purell brand hand sanitizer is better at inhibiting the growth of bacteria than Equate.*

2. Support your claim with **Evidence**. Provide specific facts and data from your experiment (or another reliable source) to support your claim. Reference your graphs or data tables directly.

Example: *When we compared the zones of inhibition around filter papers dipped in hand sanitizers and placed on an agar gel coated in E.coli bacteria, the Purell disc had the largest bacteria-free zone. The diameter of the Purell zone of inhibition was 3 cm compared to 2 cm for Equate and 0 cm for a paper dipped in distilled water. Purell was 50% more lethal than Equate.*

3. Now, provide **Reasoning** to explain why your evidence supports your claim. This is sometimes the hardest part! You must find a reason why your experiment turned out the way it did. If you think you had errors or problems that led to a false conclusion, explain them in this section. Be sure to add NEW insight or research to help explain why this may have occurred.

Example: *Based on this evidence, we conclude that Purell is better at stopping the growth of bacteria because it had the largest zones of inhibition around the disc after 24 hours of growth.*

4. Include a citation in MLA format for your **Research**. Make sure it is a reliable source.

Example: *This makes sense because according to USCB Science Line, alcohol kills bacteria by dissolving their cell membranes and denaturing their proteins. Purell (95%) had a higher alcohol content than Equate (62%) and a 100% higher alcohol content than distilled water.*

USCB ScienceLine. "How does ethyl alcohol kill bacteria?" *UCSB*. 21 Oct. 2009, <http://scienceline.ucsb.edu/getkey.php?key=2160>. Accessed 4 Sept. 2017.

CER Grading Rubric

Discussion and Conclusion sections in your lab notebooks will be graded according to this scale.

	3	2	1	0
Claim	Fully and clearly answers question.	Addresses question but is unclear or vague.	Doesn't address question. Incomplete.	No claim
Evidence	Specific data used appropriately.	Some data included; not sufficiently explained.	Lacks specific data and analysis. Incomplete.	No evidence
Reasoning	Relates directly to all pieces of evidence.	Relates to claim, but isn't specific to evidence	Lacks connection to claim and evidence.	No reasoning
*Research	Connects specific reasoning to scientific concepts.	Adds to reasoning but lacks connection to scientific concepts.	Lacks connection to reasoning and scientific concept.	No research

**Research was only required in the longer assignments (lab write-ups and essay), not in the daily bell-ringers. Scale was adjusted to a total of 3 for all assignments.*