Project-Based Writing in Science

Lawrence Baines

SensePublishers

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Scope:
Bold Visions in Educational Research is international in scope and includes books from two areas: *teaching and learning to teach* and *research methods in education*. Each area contains multi-authored handbooks of approximately 200,000 words and monographs (authored and edited collections) of approximately 130,000 words. All books are scholarly, written to engage specified readers and catalyze changes in policies and practices. Defining characteristics of books in the series are their explicit uses of theory and associated methodologies to address important problems. We invite books from across a theoretical and methodological spectrum from scholars employing quantitative, statistical, experimental, ethnographic, semiotic, hermeneutic, historical, ethnomethodological, phenomenological, case studies, action, cultural studies, content analysis, rhetorical, deconstructive, critical, literary, aesthetic and other research methods.

Books on *teaching and learning to teach* focus on any of the curriculum areas (e.g., literacy, science, mathematics, social science), in and out of school settings, and points along the age continuum (pre K to adult). The purpose of books on *research methods in education* is **not** to present generalized and abstract procedures but to show how research is undertaken, highlighting the particulars that pertain to a study. Each book brings to the foreground those details that must be considered at every step on the way to doing a good study. The goal is **not** to show how generalizable methods are but to present rich descriptions to show how research is enacted. The books focus on methodology, within a context of substantive results so that methods, theory, and the processes leading to empirical analyses and outcomes are juxtaposed. In this way method is not reified, but is explored within well-described contexts and the emergent research outcomes. Three illustrative examples of books are those that allow proponents of particular perspectives to interact and debate, comprehensive handbooks where leading scholars explore particular genres of inquiry in detail, and introductory texts to particular educational research methods/ issues of interest to novice researchers.

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To mom, as always

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FOREWORD TO LAWRENCE BAINES' PROJECT-BASED WRITING IN SCIENCE

BY DR. MICHAEL L. BENTLEY

> "If you cannot – in the long run – tell someone what you have been doing, your doing has been worthless." - Nobel Laureate Edwin Schrodinger (1951)

As a science teacher or teacher educator, you will find this a very engaging book. The first thing that came to my mind when I read it was how I would use it in my courses in elementary and secondary science teaching methods. In fact, I used a few things from the book right away, sharing with my students Chapter One's of eight essential science websites, as well as the possible writing assignments that were itemized and the "Listener Out-of-Class" worksheet. The latter accompanies Lawrence Baines' suggestion about the value of students sharing their work with people other than their teachers. After the student reads to him or her, that selected listener, or "LOC," writes down the student's responses to a few questions about the piece, and gives it back to the student to submit as his or her homework assignment. Addressing an outside audience lets the student explain one or more science concepts to someone else, and thereby develop his or her own understanding. In addition, the child's teacher escapes some of the dreaded chore of grading and gets valuable free help in providing formative assessment.

For anyone like myself who is regularly engaged in teacher preparation and credentialing and professional development courses, this book presents a well-researched argument for why writing should be emphasized as a key teaching method in science education at all levels. In addition to providing a substantial rationale for the pedagogy, Baines provides a set of five examples in different science disciplines that demonstrate specifically how writing can be used to make instruction more effective at the classroom lesson level. Better yet, these lessons represent "best practices" in science teaching because they all incorporate inquiry and active learning strategies. And certainly the various levels of writing tasks suggested in the sample lessons are all "minds-on" strategies.

This is a book that John Dewey would very much appreciate. Dewey is associated with the idea that 'we learn by doing' but his position perhaps is confused with the Chinese saying, 'I do, and I understand.' But what Dewey actually wrote was, "Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results." So, what Dewey really means is that we learn by *thinking*. And Lawrence Baines shares with fellow educators a number of strategies to get kids to think more deeply (through writing) about the science content of the classroom curriculum. Few students will be able to resist being

engaged with the real-life scenarios and fascinating science in the sample lessons. Most of the lessons could be adapted for classroom use in upper elementary, middle and high school, and even college science classes. They are also great examples of integrating science and language arts in the classroom curriculum that teacher educators like me can use in undergraduate and graduate science methods courses and in professional development workshops.

Chapter 1 in this book describes three levels of student writing, a useful categorization for making assignments and helpful in assessing student work. The "quickwrite" is completed by students in a few minutes and represents a level one writing assignment. Baines states, "The purpose of a quickwrite may be to give students the opportunity to capture their thoughts at a particular moment in time and put them into words. Without the time to reflect, scientific concepts can quickly turn into confused notions…"

The quickwrite exercise helps students focus and reflect on the content but is usually not graded. It is also is a way for the teacher to guide student thinking in a desired direction. The next level writing assignment, level two, falls between this and a research-type paper, or term paper, which represents the level three writing assignment. As Baines notes, most writing in the science classroom is to inform or persuade a specific audience, and all requires some degree of reflection on the facts and concepts of the lesson. The level 3 is the most demanding work and usually a more long-term project.

In Chapter 2 Baines shares a number of valuable ways teachers can reduce the time normally spent grading papers, tips that most teachers will find especially helpful. He describes one teacher who only gives grades of zero or A to students on their writing assignments. While this may sound harsh, the teacher has found that students have responded well to the challenge and he has few failures. The secret strategy is how he enables students to get help from peers and other adults. From assessing student writing, a teacher can quickly grasp where comprehension is solid and where it breaks down. In this chapter Baines recommends teachers share scoring rubrics for assignments with students so that the grading criteria are up front. As one who uses rubrics in teaching, I can testify that they are very helpful in both guiding students in their work and in later justifying an evaluation to the student and to others if necessary, such as instructional supervisors and parents during parent-teacher conferences. Finally in Chapter 2, Baines discusses the National Assessment of Educational Progress and the criteria for evaluating writing used in its prestigious national assessments, criteria that can be used by science teachers in assessing student writing.

In his earlier book, *A teacher's guide to multisensory learning*, Baines (2008) wrote about the value of simulations in teaching and learning. In terms of impact, he claims that learning through simulations and models is second only to direct, physical experience, and I concur. In fact, medical training, pilot training, and military training are all dependent upon realistic simulations of what the learner will likely encounter in his or her professional practice. In Chapters 3 to 7 Baines

provides sample lessons in which the main context of learning is often a realistic and engaging simulation.

The five chapters representing model lessons are well organized and go right to the point for quick access. In each Baines provides a description of the activity, relevant research, anchor points and a challenge to focus the study, a timeline, concise objectives, a summary of the lesson, required materials, a list of essential websites, how to set up the lesson, a detailed but succinct procedure indicating where writing activities occur in the sequence, clarifying comments, ideas for enrichment activities, annotated references, and finally, recommendations for assessment. Many of the lessons also include useful reproducible handouts and worksheets.

In Chapter 3, 'Going Viral,' Baines first presents a number of dramatic facts about viruses that are bound to capture student imagination. He follows with a lesson scenario in which the World Health Organization (WHO) asks for help in preventing a pandemic of the bird flu. Students soak up a lot of the biology of cells in the role-play as they create an action plan that will prevent a pandemic. In this chapter Baines refers to several of my favorite books that featured viruses threatening human populations: Stephen King's *The Stand*, Robin Cook's *Contagion* (about Ebola Hemorrhagic Fever), Michael Crichton's *Andromeda Strain*, and Richard Preston's *The Hot Zone*, real-life bio-thriller about a mutated form of Ebola called Reston virus (RESTV) discovered in Reston, Virginia in the early 1990s, less than 24 km. from Washington, DC. These Biosafety Level 4 agents are so dangerous to humans because they are highly infectious, have a high death rate, and have no known cures. Working on this simulation will likely lead students to become interested in infectious diseases and especially these exotic tropical diseases. No doubt many will delve into these chilling fictional and non-fiction books.

Chapter 4 is titled, 'Survival of the Smartest.' Here Baines structures an inquiry lesson around a survival simulation that actually taps into the *U.S. Army Survival Manual*. He argues that if students learn about real risks associated with environments like deserts and conditions like hypothermia and how they could survive themselves when exposed to hazardous situations, they will use their higher order reasoning skills to propose possible solutions in the role-play. The six different survival situations presented in the chapter will challenge students with multiple problems and complications. Thinking through all the options will require them to analyze, synthesize, and evaluate how they might survive. This is truly a simulation that could pay off for some of them in the future!

Chapter 5 is about the physics of running and while not based upon a simulation activity, students will find this study very engaging too (because it is about themselves) – and may even lead to improving their health and performance. Most students like and follow sports and the exercises in this chapter provides them with basic knowledge of the laws of motion as well as how to measure relevant bodily parameters related to speed, velocity, displacement, distance, and friction. As Herman (2008) notes, "Physics explains everything from the beginning to the end of any complete description of the human body" (p. vii). Completing the worksheets

provided at the end of the chapter require team/group work in the out of doors and focus on measuring, recording, graphing and interpreting results.

In Chapter 6, The Fight for Water, Baines addresses a global environmental problem that particularly affects communities in the Western United States which depends on groundwater from the vast Ogallala Aquifer, which lies under 453,000 square kilometers in Kansas, Nebraska, South Dakota, Colorado, Oklahoma, Texas, Wyoming and New Mexico and yields 30 percent of the nation's irrigated groundwater. This fossil water, left over from the melting of the last continental glaciers 11,000 years ago, is rapidly being drawn down. In fact, in 2011 Kansas alone pumped out 1.3 trillion gallons, more than enough to fill Lake Okeechobee in Florida! Geologists estimate that if the drawdown stops now, it would still take about a thousand years to replenish it. They predict that at current rates of extraction it will be 70 percent gone by 2060.

Actually, few people really grasp how little fresh water is available to us. Surface water, found in rivers and lakes, makes up only 1% of all fresh water and many people around the world lack access to it. For this simulation, students are challenged to deal with water management for the city of Las Vegas, Nevada, whose source is the Colorado River reservoir at Lake Mead. Water levels there have fallen steadily for nearly a decade and so water is one of the most politically charged local issues,

and certainly one of the most important. In this simulation students have to analyze water usage and devise a 10-year plan for the city's water. Students have to consider geography, public policy, individual rights, and governmental authority versus private property rights. In drawing up a plan they learn about population growth and the increasing demand for water, the different sources and uses of water in a city, and the costs involved in providing potable water from sources far away.

The final chapter, 'It's a Dog's Life.' is one of my favorites, and I have to confess that I shared several ideas about multimedia assignments from this chapter with my pre-service teacher education class. The science is about classification and requires students to observe and document, research, analyze, and categorize animals and plants that they find at home or in their neighborhood environment. The product of the study is a descriptive photo essay that ranks as a level 3 research paper. The medium will intrigue students and most will love sharing information about their pets and the plants and associated critters where they live.

In concluding, I want to mention that in Chapter 1 Baines cites Jared Diamond's Pulitzer-prize-winning book *Guns, Germs, and Steel* (1997) as an example of a well-researched attempt to persuade. Diamond posits that environmental factors may account for the decline and failure of one culture and the flourishing of another, rather than cultural factors, like intelligence or work ethic. I found this to be a fascinating treatise and so was his follow-up, *Collapse: How Societies Choose to Fail or Succeed* (2011), in which he argues that environmental issues are often the main catalyst for decline, especially when combined with a society's disregard for what is happening. Diamond, I think, wants us to be aware of these past societal experiences, so we will avoid potential devastations to come. *Collapse* is a compelling read and global climate change looms, in my opinion, as one of the greatest challenges facing humanity (and all the other species on the Earth as well). I believe the kind of science teaching exemplified in Lawrence Baines' *Project-Based Writing in Science* is part of the solution: educating our students to think and act in effective ways to survive and preserve our precious planet.

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CHAPTER 1

PROJECT-BASED WRITING IN SCIENCE

It is incredible to consider that writing has not always been an integral part of the science curriculum. After all, the world's greatest scientists are known as much for what they wrote as what they contributed to science. It would be difficult to separate Charles Darwin from *The Origin of Species*, Isaac Newton from *Principia Mathematica*, Nicolaus Copernicus from *On the Revolutions of Heavenly Spheres*, E. O. Wilson from *On Human Nature*, Albert Einstein from "On the Electrodynamics of Moving Bodies," or James D. Watson from *The Double Helix*.

Indeed, book bestseller lists commonly feature works by scientists, such as Primo Levi, Brian Green, Michio Kaku, Richard Dawkins, and Oliver Sacks. Novelist Michael Crichton was an MD and graduate of Harvard Medical School; prolific science fiction writer Isaac Asimov was a professor of biochemistry at Boston University who also happened to write books, more than 500 of them. The interplay between writing and scientific advancement has a long, illustrious history.

According to the National Research Council, about half of the time spent by scientists and engineers is spent reading and writing (2011). Thus, writing not

only helps students learn, but writing also has the advantage of helping to develop skills that will prove useful for students in "life after high school." The College Board (2004) classifies writing as a "threshold skill," meaning that the ability to write serves as a gateway, or threshold, to more intellectually-demanding, more responsible, higher-paying jobs. In a survey of 120 American companies, writing was cited as one of the most indispensible skills that a prospective employee could possess (College Board, 2004). The survey also revealed that:

- Two-thirds of salaried employees in large American companies have some writing responsibility.
- Eighty percent or more of the companies with the greatest employment growth potential, assess writing during hiring.
- More than half of all responding companies report that they "frequently" or "almost always" produce technical reports (59 percent), formal reports (62 percent), and memos and correspondence (70 percent). (pp. 3-4)

Today, the centrality of writing in science is acknowledged in the New Generation Science Standards (2013), with its emphasis on "cross-cutting concepts," "planning and conducting investigations," and "communicating scientific and technical information" (pp. 33-39; 65-73). Reports from the Organization of Economic Cooperation and Development (OECD, 2012) confirm the centrality of science and innovative thinking to the quality of life across the globe.

The Common Core State Standards (CCSS) Initiative in the United States, which pledges to make all students "college and career ready," insists that students must be "prepared to read, write, and research across the curriculum, including in history and science" (2013). Writing is "essential to the economic success of the nation," according to a 2010 report from NAEP, the National Assessment of Educational Progress (p. 1).

However, the importance of writing in science goes beyond the directives of the CCSS, New Generation Science Standards, and the NAEP. Perhaps the strongest proof of the importance of writing in science is the multitude of journals, newspapers, newsletters, blogs, and websites dedicated to communicating the latest, greatest breakthroughs. Judging from the popularity of science websites, writing in science has a massive and expanding fan base. Some useful science websites are as follows:

Although it is not yet in the top ten of most popular websites, WolframAlpha is a massive search engine for mathematics and science that is being utilized in educational settings throughout the world. A beta site, expressly for educators, which contains lessons, demonstrations, and online articles and books is located at http://education.wolfram.com.

When J. Craig Venter's team developed the first "synthetic life," an artificial version of the bacterium Mycoplasma mycoides in May 2010, headlines proclaiming the event could be found on websites and newspapers throughout the world, including *The New York Times*. In fact, a search on The *New York Times* database reveals more than seventy articles on J. Craig Venter.

Figure 1. Essential science websites

Organization and website address	Unique visitors per month	Focus of the website
National Oceanic and Atmospheric Administration (NOAA) www.noaa.gov	10 million	The website states, "From daily weather forecasts, severe storm warnings and climate monitoring to fisheries management, coastal restoration and supporting marine commerce, NOAA's products and services support economic vitality and affect more than one-third of America's gross domestic product."
National Aeronautics and Space Administration (NASA) www.nasa.gov	9 million	The site features large, "for educators" sections, designated by grade level, from kindergarten to higher education.
Science Direct www.Sciencedirect.com	4.5 million	The site serves as a clearing house of sorts for scientific journals and includes a list of "hottest 25 articles" by area of interest.
Science Daily www.sciencedaily.com	2.4 million	The site features daily breaking news, summaries of important articles in academic journals, and recent scientific discoveries.
Nature www.nature.com	1.8 million	One of the most respected weekly, international science journal in the world.
Popular Science www.popsci.com	1.4 million	Despite the irritating ads, this website sometimes features highly engaging articles told in everyday language.
New Scientist www.newscientist.com	1 million	Features interesting stories on a variety of topics, including the environment, health, physics/math, and science in society
Live Science www.livescience.com	Almost 1 million	Features image galleries, collections of infographics, and "coolest science stories of the week."

(Estimate for unique visitors per month from Ebizmba, 2013)

Indeed, the rate of change in science is one reason that the field is so exciting. It is impossible for even the most contemporary e-textbook to capture the current state of science or to anticipate all of the disruptive discoveries on the horizon. Thus, although most recently published science textbooks are beautifully-constructed and well-organized, when considering the latest developments in science, a teacher may want to supplement the textbook with outside resources. Articles, images, and video from most science websites are open access and can be used freely by teachers for face-to-face, classroom instruction.

THE POWER OF WRITING

Writing is a convenient way to record observations, crystalize thinking, gain an understanding of scientific concepts, and contemplate the vast world of possibilities.

"In an era in which many of the borders that have long separated the world's peoples blur, exploring and sharing human experience through writing helps define not only individual identity but also the universal connections that people share" (National Assessment of Educational Progress, 2010, p. 3).

However, simply assigning more writing will not magically transform students into highly-engaged, eloquent, scholars of science. Writing assignments must be strategic, purposeful, and—perhaps most important of all—interesting. When making an initial writing assignment, an effective strategy is to focus on the conceptual big picture before delving into the gory details and sophisticated nomenclature endemic to specialized areas of study. Once students understand the basic concepts, then details are more likely to stick.

About the importance of piquing student interest, Farr (2013) writes:

> A thoroughly researched conclusion about learning is that students will put in the time and energy necessary to learn if they are interested in what they are learning and if they can relate to it. (p. 2)

Making attractive entry points for writing is well worth the effort. Linking material to current news stories or events is one way to garner student interest. As well, there is no shortage of modern-day, science-related challenges that could serve as compelling entry points—species extinction, bio-engineered food, the ethics of nanotechnological engineering, pollution, population density, natural resource depletion, water, energy supply, the list seems endless. Learning about these challenges in the context of science and the realities of modern life can provide powerful incentives for writing.

WRITING AND STANDARDS

Perhaps the table that has appeared most often on school district memoranda concerning the Common Core in the United States is the chart explicating the desired ratio between fiction and nonfiction texts over time.

Figure 2. Ratio of reading literary vs. informational texts, suggested by Common Core

	Grade 4	Grade 8	Grade 12
Literary texts	50	45	30
Informational texts	50	55	70

The basic point of the table is that, over time, students should have ever-expanding opportunities to read nonfiction texts in all of their classes. Of course, the logical next step after reading a variety of nonfiction texts is to have students create nonfiction texts of their own. Indeed, the kind of reading that students are expected to do aligns with the kind of writing that students are expected to do.

Common Core State Standards emphasize unequivocally that persuasive and informative writing should take precedence over other kinds of writing:

> Evidence concerning the demands of college and career readiness gathered during development of the Standards concurs with NAEP's shifting emphases: standards for grades 9–12 describe writing in all three forms, but, consistent with NAEP, the overwhelming focus of writing throughout high school should be on arguments and informative/explanatory texts. (Common Core State Standards, 2013)

The writing prompts for the Common Core are based, to a large extent, upon long-established NAEP assessments. As indicated in Table 3 below, when the NAEP assesses writing, 80% of students will receive prompts that ask them to write an informative or persuasive essay, while only 20% will be asked to "convey experience." The inference is that the increase in persuasive and informative writing prompts should be reflected in a school's curriculum. In other words, as students get older, writing assignments should increasingly steer them towards persuasive and informative writing.

Figure 3. Writing prompts for the NAEP (2010)

	Grade 4	*Grade 8*	*Grade 12*
To persuade	*30*	*35*	*40*
To inform	*35*	*35*	*40*
To convey experience	*35*	*30*	*20*

INFORMATIVE WRITING

One of the most common forms of writing for scientists is the lab report, which attempts to capture accurate details and explicit results from experiments. The lab report is a classic, widely-acknowledged form of informative writing. The NAEP elaborates on the purposes of informative writing:

> Informative writing focuses primarily on the subject matter element in communication. This type of writing is used to share knowledge and to convey messages, instructions, and ideas. Like all writing, informative writing may be filtered through the writer's impressions, understanding, and feelings. Used as a means of exploration, informative writing helps both the writer and the reader to learn new ideas and to reexamine old conclusions. Informative writing may also involve reporting on events or experiences, or analyzing concepts and relationships, including developing hypotheses and generalizations. (National Association of Educational Progress, 2000, p. 3)

In addition to laboratory reports, any writing based upon observation and description may be categorized as informative. For example, asking students to investigate and communicate the habits, environment, and characteristics of a particular animal might make a good informative writing assignment (chapter 7). Describing how bacteria invade a cell, mutate, and replicate might serve as another topic for an informative piece of writing (chapter 3).

Explication, exposition, and *explanation* are terms that are often used interchangeably with *informative writing*. Although each term may have once possessed a distinctive connotation, in practice, *explication, exposition*, and *explanation* have become synonymous with *informative writing*.

PERSUASIVE WRITING

If you want to find an example of persuasive writing, you only have to peruse any grant application seeking funding support (money) from the National Science Foundation or the National Institutes of Health. The purpose of every grant application is to persuade an organization's review board that the proposed work is worthy of a significant influx of money. Guidelines for the NAEP Persuasive Writing Assessment are as follows.

> Persuasive writing focuses on the reader. Its primary aim is to influence others to take some action or bring about change. Persuasive writing may contain great amounts of information—facts, details, examples, comparisons, statistics, or anecdotes—but its main purpose is not simply to inform but to persuade. This type of writing involves a clear awareness of what arguments might most affect the audience being addressed. Writing persuasively also requires use of critical thinking skills such as analysis, inference, synthesis, and evaluation. Persuasive writing is called for in a variety of situations. It may involve making a response to a request for advice by giving an opinion and providing sound reasons to support it. It may also involve presenting an argument in a way that a particular audience will find convincing. When there is opposition, persuasive writing may entail refuting arguments that are contrary to the writer's point of view. (National Assessment of Educational Progress, 2010, p. 5)

Persuasive writing offers teachers rich opportunities to promote critical thinking, research, and presentation skills. A persuasive writing assignment might ask students to consider the problem of water scarcity in a particular region and to devise a plan to address the scarcity problem by providing a well-supported, detailed plan of action (chapter 6).

Jared Diamond's Pulitzer-prize-winning book *Guns, Germs, and Steel* (1997) is a detailed, well-researched, attempt to persuade. Diamond's thesis is that the reason one culture flourishes while another culture declines may be due to environmental factors, such as geography, climate, and access to natural resources—not cultural factors, such as ingenuity or work ethic. Diamond lays out his theory by drawing on studies from

a variety of disciplines. Even academics who argue vociferously against Diamond's conclusions cannot help but marvel at the scope of his research. Similarly, a teacher of science may not always agree with a student's conclusions, but the teacher can certainly assess the extent to which the student provided adequate, valid supporting arguments.

In many ways, persuasive writing forces students to weigh evidence, to reflect, and to critically assess implications. In other words, persuasive writing pushes students to consider science-in-action.

Is it better for a woman to give birth naturally or via a Caesarian section? What is the universe made of? How long can a human being live? What would be the best plan for supplying water to a large city in the middle of a desert? These are the type of questions that require significant thought and effort and require a persuasive response.

NARRATIVE WRITING (ALSO KNOWN AS "TO CONVEY EXPERIENCE")

A third kind of writing used to be called narrative or "storytelling" (National Assessment of Educational Progress, 1997), but is now known by the moniker, "to convey experience." While writing that conveys experience is not emphasized as much as persuasive or informative writing in standards documents, conveying experience has been a primary function of writing, at least since around 2500 BCE.

Recently, the NAEP broadened the scope of what had been called *narrative* to encompass imagined experiences, leaving open the possibility for assignments that are exploratory or experimental. Einstein's famous vision that lead to the theory of relativity, in which he rides at the speed of light alongside a light beam (Stinnis & Metz, 2004) would qualify as a kind of "thought experiment" that would convey *imagined* experience. When the term *narrative* is used in this book, it will be the broadened sense of the word, including *conveying experience, real and imagined*.

Despite their distinctive traits, the three types of writing required by Common Core—persuasive, informative, and narrative—are not mutually exclusive.

For example, in the book *Complications* (2008), Dr. Atwul Gawande describes an encounter with a 400-pound compulsive eater with multiple health, psychological, and personal problems. In the course of telling the story, Gawande discusses the biological basis of hunger, the digestive system, the stress that obesity places on the body, and intricate details of gastric bypass surgery. Certainly, Gawande's narrative about "The man who couldn't stop eating" is informative, but it also persuades. After reading the story, most readers will be convinced that obesity is unhealthy, socially debilitating, and potentially deadly.

Expressive Writing

Of course, many different kinds of writing exist beyond the "big three" pantheon of persuasive, informative, and narrative writing. The most obvious exclusion from the pantheon is expressive writing, the kind of writing that frequently fills diaries and shows up on social media sites, such as Facebook.

Expressive writing, or "writing what you think" may not seem substantial at first blush, but writing expressively is often a necessary first step to more complex assignments. Here is how expressive writing might work in a class on friction and the laws of motion.

Figure 4. How a science teacher might use expressive writing.

After discussing the concept of friction and the laws of motion in class, a teacher decides to conduct a brief experiment. So, she brings to class a golf ball, a steel ball bearing, and a glass bowl. First, she spins the golf ball in the glass bowl and measures the time it takes for the golf ball to stop spinning. She announces the time and writes it on the board.

She asks students, "Take three minutes and explain what is happening in this glass bowl in terms of the golf ball, friction, and the laws of motion."

After three minutes, she asks a few students to read what they have written aloud. At this point, most students in class may be tentative, so the teacher highlights student comments that are accurate and corrects student comments that are not, revisiting Newton's laws of motion when appropriate.

Then, she holds up the steel ball bearing and asks, "What is going to happen when I spin the steel ball bearing in the bowl? Will it spin for a longer or shorter time? Make a prediction of how long it sill spin and explain why in terms of friction and the laws of motion. Take 3 minutes to write a prediction and a rationale."

Before spinning the steel ball in the glass bowl, the teacher asks several students to read aloud their predictions and rationales. Then, she spins the steel ball bearing in the glass bowl, announces the elapsed time, writes it on the board next to the golf ball's time, congratulates students with the most accurate predictions, and makes some final points. These two expressive, quick-writes would require students to apply their knowledge to a new situation, obliging them to conduct a mini-thought experiment of sorts. Such assignments can serve as prelude to a subsequent, more formal experiment and report.

The teacher says, "Please turn in your quickwrite. I will give them a 'quickcheck' to see how well you are understanding friction and the laws of motion." After class, the teacher scans student papers and gives a "check" in the gradebook to denote completion of the task. Alternatively, the teacher could have asked students to keep their papers in notebooks, which the teacher would pick up occasionally (unannounced) to monitor student participation and comprehension.

Before asking students to complete a formal writing task, such as a persuasive essay or an informative research paper, it may be beneficial for them to first have accumulated a series of non-graded, expressive, quick-writes. Then, when the longer paper is assigned, students have a ready-made pile of writing upon which to draw. This manner of using more informal assignments to provide a foundation for subsequent, more formal writing avoids the "terror of the blank page" syndrome.

When students in class despair that, "I don't know what to write" in response to an assignment, it is usually because they have not yet decided what they think. Expressive writing helps students decide what they think and makes the jump to more complex writing less daunting.

Even the NAEP acknowledges the centrality of expressive writing.

> Many writing situations encourage students to write as a means of self-expression and comprehension, as is the case with writing-to-learn activities when the student composes as a means of thinking through key ideas on a topic. The importance of written communication for personal purposes cannot be overstated: students given adequate practice in developing their own thoughts and feelings through such writing are better able to perform well in all forms of writing. (National Assessment of Educational Progress, 2010, pp. 3-4)

It is unreasonable to expect students to instantly write as if they were experts about a new concept within the time limitations of a class or two. Expressive writing provides the scaffolding necessary for students to move from vague ideas to knowledge and application.

CREATIVE WRITING AND MIXED MEDIA

Students need exposure to different kinds of writing. A steady diet of informative writing and nothing but informative writing might not be optimal for a student's cognitive development. Assigning a variety of writing tasks—expressive, narrative, persuasive, informative—is a good way to help insure students learn how to write for different purposes. However, beyond these essential forms of writing, a teacher may consider other, creative possibilities that do not fall neatly into any single category. Creative writing does not have to involve writing short stories; it can be any kind of composition that does not fit neatly into a particular category.

Mixed media writing, which combines various kinds of writing with electronic media, gets easier with each new wave of technological advance. Armed with a simple cell phone, it is possible to combine drawings with narrative text, photographs with informational text, film with persuasive text, audio with expressive text, or myriad other combinations.

In many ways, mixed media writing is the future. Consider the following statistics about the popular video site, Youtube (YouTube, 2013).

- More than 1 billion unique users visit YouTube each month
- Over 6 billion hours of video are watched each month on YouTube, or about an hour of video viewing for every person on earth
- 100 hours of video are uploaded to YouTube every minute
- 70% of YouTube traffic comes from outside the US
- YouTube exists in 56 countries and across 61 languages
- YouTube reaches more US adults ages 18-34 than any cable network

One of the great strengths of visual media is that they are able to imbue a message with clarity and power. High school science teacher Greg Craven posted a short,

homemade video entitled "The most terrifying video you'll ever see" on Youtube in 2007. Within six months, the video received more than four million viewings (Knickerbocker, 2007) and Craven was offered a book contract from Penguin, which eventually resulted in *What's the worst that could happen?* (Craven, 2009).

Writing assignments could take a variety of forms, including:

- quickwrite
- journal entry
- blog
- summary
- lab report
- story
- informative essay
- persuasive essay
- research paper
- script
- website
- film
- speech
- presentation
- mixed media experience
- book
- magazine
- brochure
- poster
- newsletter
- other

To expand a student's audience for writing beyond the teacher-as-evaluator is a potent idea that can genuinely foster student engagement. For a group research project, a teacher might ask each group of students to film their oral presentations and post them on Youtube, Vimeo, or another video website so that students in other classes, parents, and friends could see them. In this book, all graded (level 3) writing assignments involve mixed-media.

SPECIFY THE AUDIENCE

Think about how differently you would communicate a description of a recent car accident to different audiences—a classroom of second graders at a local elementary school, a buddy at a nightclub, and the insurance adjuster at his office. If you want students to create a brilliant, in-depth piece of writing, they are going to need to know for whom they are writing. In most science classrooms, 100% of assignments are created for an audience of one—the teacher—who typically evaluates a paper for correctness and then assigns a grade. However, a teacher need not serve as the sole-evaluator-in-residence for every writing assignment.

Sometimes, students could write to the teacher-as-editor to receive friendly advice on what to improve before re-submitting a paper for a grade. Or, students could write for their peers in class, parents, a general audience on the web, students in a sixth grade class in Mexico City, or the board of directors at NASA (National Aeronautics and Space Administration).

Some creative science teachers routinely require students to read papers to non-science-oriented adults, such as an English teacher, an uncle, or the custodian. Implementing this innovation is easy and straightforward. Students simply give a one-page form to a listener to complete. The LOC (listener-out-of-class) form asks the listener to rate the quality of the student's oral delivery, clarity of expression, and ability to answer questions. See an example of the form in Figure 5.

Figure 5. Listener Out-of-Class (LOC).

Student name_____ Date_____

Your name_____
Occupation_____

Students in _____'s science class must read their papers aloud to a variety of audiences. Congratulations! You have been chosen as an audience! Thanks for helping.

Your honest assessment of this written response will help establish the student's understanding of concepts and ideas covered in class. The entire assessment should take less than 5 minutes.

Write answers below. When you are done, please give the form back to the student, who will return the form to the teacher. Additional comments and questions are welcome.

1. Summarize the main idea of the passage that the student read aloud. You may ask the student to re-read the passage or to elaborate on any part of it.
2. Pose a question to the student related to this piece of writing. Please write the question below.
3. Summarize the student's response to the question.
4. Additional comments?

THANK YOU.

Teacher's name
School
Email address
Telephone number

The entire interchange between student and adult listener should take five minutes or less. The listener writes down student responses, hands the form back to the student, who turns it in to the teacher. Providing an "outside audience" gives students the chance to translate scientific concepts into everyday language, which, in turn, helps enhance understanding. Additional advantages of using an audience other than teacher-as-evaluator include:

1. The LOC one-pager provides a checkpoint for student mastery of a concept
2. The LOC one-pager provides an audience other than teacher-as-evaluator
3. The LOC one-pager is completed by listening adults, thereby reducing the paper load of the teacher.

Audience influences word choice, sentence structure, organization, and most aspects of writing. Before beginning to write, it would be useful to know for whom the writing is intended. Some possible audiences include:

teacher as evaluator (graded)
teacher as writing coach (non-graded)
other teachers
family members
social workers
chamber of commerce
science fair judges
peers
a hostile audience
online general audience
experts
novices
younger audiences (for example, third graders at a nearby school)
older audiences (for example, individuals living in a retirement home)
non-native speakers
other

A final consideration for audience is the decision for the student concerning whether or not to seek publication. Print and online magazines eagerly accept submissions and having a student's work appear in a high-visibility publication can be a boon to the student, parents, teacher, and school.

SELECT THE MEDIUM

The traditional writing assignment in science has been text and nothing but text. However, other possibilities abound—film, websites, presentations, podcasts, mixed media, even theatrical performance (see Tom Stoppard's *Arcadia* for an example of a recent theatrical

production in which science plays a prominent role). At the least, a teacher should consider requiring students to supplement textual reports with images and/or sound.

DETERMINE THE LENGTH OF TIME STUDENTS GET TO WRITE

Quickwrites are usually done spontaneously and completed in a matter of minutes. The NAEP writing assessment, as with most writing assessments, usually give students about 30 minutes to complete an essay. Longer research papers may take anywhere from a few days to several weeks to complete. The range of times designated for assignments over the course of a term might include writing completed in:

3 minutes
30 minutes
One day (due at the end of the period)
Several days
Two weeks
A semester

As with purpose and audience, the best approach may be to expose students to a variety of timed writing experiences. Some writing may be done quickly and handed in immediately with no chance for revision. Other writing may entail significant amounts of research, require multiple drafts, and necessitate revision outside of class.

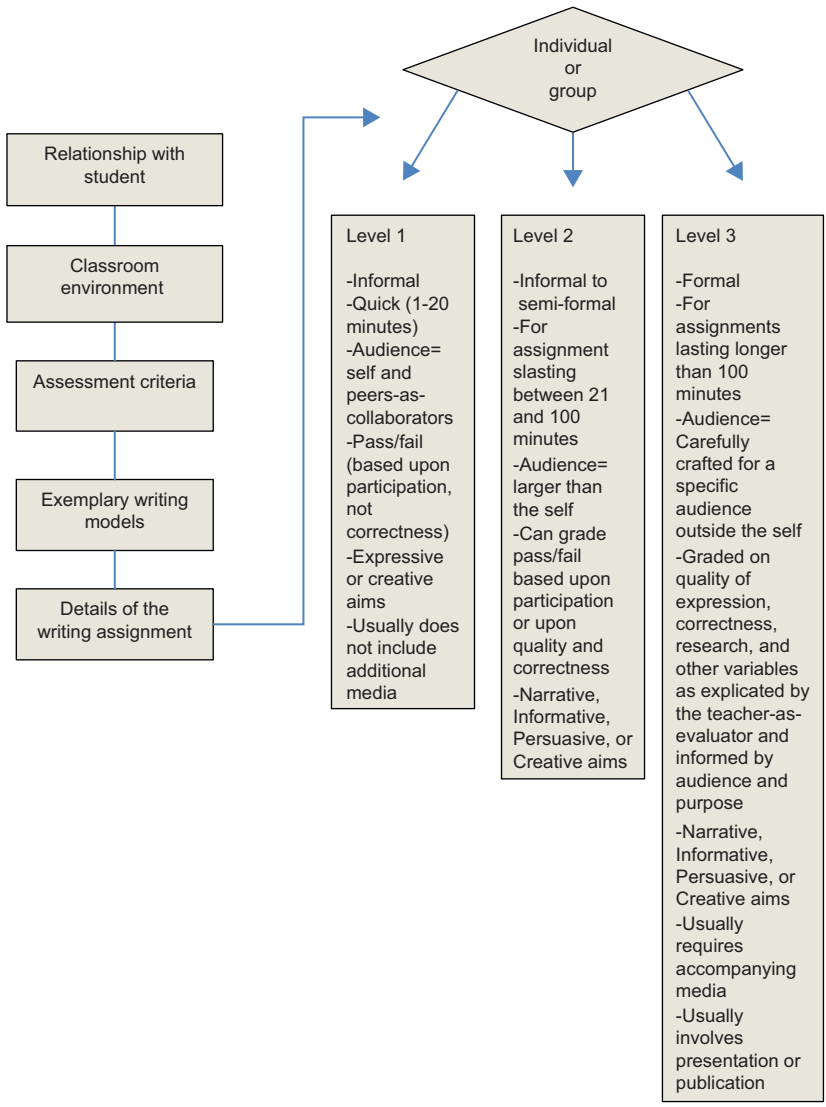
OTHER FACTORS

The life of a teacher is greatly simplified if he/she decides that the default for writing assignments is that they will be graded on "completion." Basically, this translates into giving students credit for thinking through the written word. If students can get used to articulating what they think, then it becomes easier for a teacher to discern when a student gets lost or misconstrues a concept. Also, it allows for greater accuracy when attempting to scaffold student learning.

This kind of formative assessment also prevents every writing assignment from turning into a time-consuming, tension-inducing ordeal. If the default for a writing assignment is non-graded, then a teacher can scan what has been written and offer a quick response. If concern grows that students are not taking the non-graded writing assignment seriously enough, then selecting a random written response for-a-grade is always an option.

Another factor, the collaborative nature of learning, has become a hot topic in education circles (Day & Bryce, 2013; Topping, Thurston, Tolmie, Christie, Murray, & Karagiannidou, 2011). While students can definitely benefit from participating as part of a larger group, particularly when engaging in research, relying solely upon

a group grade for writing is not best practice—for several reasons. First, in life, as in the classroom, there are always students who will strive for the "highest possible grade" for the "lowest possible effort." To combat this tendency, a teacher must keep students culpable for their individual performance, as well as their contribution as part of a larger team. Thus, when working with groups, taking both an individual grade and a group grade is a good idea.



FLOWCHART FOR WRITING

The foundation for writing in science is the teacher's relationship with the student (Stormer, 2013). If the student trusts and respects the teacher, then much can be accomplished. If the student does not trust or respect the teacher, however, the student may be reluctant to write or to put forth much effort. Certainly, the profusion of studies supporting the influence of non-cognitive factors on learning must be given serious consideration (Farrington, Roderick, Allensworth, Nagaoka, Keyes, Johnson, & Beechum, 2012).

Related to the teacher's relationship to the student is the environment of the classroom. The physical environment can act as continuous teacher's aide, stimulating interest in science and helping students learn. Conversely, with barren walls and a dearth of gadgets, charts, recent books, magazines, and pictures, the physical classroom can act as an inhibitor. A science teacher with a sufficiently large room may designate specific spaces for "new books," reading silently, writing, discussion, tools, model student papers, or poster-building (as well as a snack bar).

For writing assignments lasting more than a few minutes, the criteria upon which the paper will be assessed should be clear. Indeed, the act of specifying what a piece of writing should contain is, in itself, a highly effective way of improving the quality of student papers (Hillocks, 1986, 1999). The idea is to demystify good writing by giving students an explicit, step-by-step guide.

Perhaps one of the most frustrating aspects of contemporary schooling for students is the dearth of models of what is considered stellar work. When trying to build anything from scratch, from a bicycle to a research brief, it helps to have a model handy to guide the effort. A word of caution: a student's very first exposure to a model has the power to forever imprint it as a prototype, so the model needs to be good. The best kind of model is a student-penned A+ paper, but examples from professional writers or from teachers will work, too. It is beneficial for students to know what "satisfactory" looks like.

One of the first decisions about making a writing assignment is determining if students will work individually or as part of a larger group. Writing of both types will be expected of students beyond high school.

A second decision is to decide on the scope of the assignment, or the level of writing.

LEVELS OF WRITING

A **level one** writing assignment may involve a simple, 3-minute, expressive, "quickwrite." Possible goals might be to help frame a topic, to assess initial understanding, to encourage speculation, or to have students attempt to discern what they think. For example, if studying taxonomy, the teacher might show a picture of a Green Sea Slug and ask if it should be classified as a plant or an animal (chapter 7). A teacher may discuss with students the characteristics of plants and animals, then assign a quickwrite, asking students to explore their thoughts on the matter.

Although it is almost always beneficial to have students read aloud their quickwrites, the usual audience for such an assignment is the self. The purpose of

a quickwrite may be to give students the opportunity to capture their thoughts at a particular moment in time and put them into words. Without the time to reflect, scientific concepts can quickly turn into confused notions and fuzzy recollections.

The teacher rarely grades a level one writing assignment. Rather, it is a tool to check comprehension or to help direct thinking in particular ways. In fact, a teacher may assign several quickwrites for various purposes within a single class period.

Unlike the level one assignment, the **level three** writing assignment requires significant thought, time, effort, and attention to the metrics of evaluation. The purpose of most level three writing is to inform or persuade a specific audience through both substance and style. Presentation or publication is often integrated into the evaluation. Level three writing is intense and time-consuming, thus should be assigned sparingly.

A **level two** writing assignment is somewhere between a quickwrite and a lengthy research paper. A teacher may want students to expound upon a previous quickwrite, go a little deeper, or start to build materials for a longer research paper. The Figure 7 below summarizes some of the characteristics of each kind of writing.

Figure 7. Levels of writing

Level	1	2	3
Formality	Informal	Informal to semi-formal	Formal
Individual/group	Individual	Individual or group	Individual or group
Time to complete the assignment	Less than 20 minutes	21 to 100 minutes	More than 100 minutes
Assessment	Participation only	Either participation or graded	Graded
Research	No	Possibly some	Yes
Presentation	Informal read aloud	Sometimes	Yes
Frequency of assignment	Daily	Whenever it can be fit into the schedule	From two weeks to a semester
Purpose	Usually Expressive	Narrative (conveying experience), Persuasive, Informative, or Creative	Narrative, Persuasive, Informative, or Creative
Audience	Self	Specific or general audience outside the self	Very specific
Medium	Usually text, sometimes text and images	Open or directed	Usually text plus charts, tables, images, and artifacts

The following twelve tips in Figure 8 summarize some major points about assigning writing.

Figure 8. Twelve tips for integrating writing into science

1. Create easy and attractive entry points. Add complexity over time.
2. Vary the stimulus. Have students write for informative, persuasive, expressive, narrative (conveying experience), and creative purposes for variable amounts of time (short, long, in-class, out-of-class, group, individual) for different audiences.
3. Use level one quickwrites and level two, non-graded writing as building blocks to longer, level three writing assignments.
4. Find current articles/books that you find interesting and bring them to class. Read aloud the text (or parts of it) in class. Explain why you find the topic interesting. Point out a sentence or two that you find eloquent.
5. Designate places in your classroom to display recent articles/books as well as model papers.
6. For level 2 and level 3 papers longer than a page, specify the audience. Encourage audiences other than the teacher-as-evaluator.
7. As much as possible, require students to integrate multisensory components, such as images, sound, charts, and video into their oral presentations. Encourage students to consider the aesthetics of their final, level 3 papers.
8. Plan for blocks of time when students focus entirely on writing.
9. Vary the medium (not just reports, but also videos, photos, presentations, brochures, and stories).
10. Assign some writing that must be completed as a group. Allow time for students to talk about their writing project with other members of their group. Set deadlines and specify individual responsibilities. Assess both individual and group performance.
11. Have students read aloud and do presentations as a matter-of-course.
12. Don’t grade everything. Spot check longer papers.

CHAPTER 2

ASSESSING WRITING WHILE MAINTAINING SANITY

Most science teachers may not find the prospect of adding piles of quickwrites and research papers onto an already heavy load of planning, lab work, teaching, and "extra-curricular responsibilities as needed" particularly enticing. For a science teacher with five classes of thirty students each, assigning a research project would mean grading 150 papers. Taking only ten minutes per paper would mean the expenditure of 1500 minutes, or a cool 25 hours of work.

However, there are ways to reduce the time spent evaluating papers, some of which were mentioned in the previous chapter.

1. Selectively choose assignments that will be graded; allowing other assignments to be part of the "science notebook"
2. Use a check system whereby the teacher quickly marks whether or not a specific part of a longer paper has been completed
3. Distribute the audience (peers, parents, other adults, experts, or review boards)
4. Assess oral presentations of written documents
5. Require students to write, edit, and seek approval for papers during class time.

A friend who teaches biology at a local high school is a strong advocate for requiring students to write, edit, and discuss papers during class time (number 5 above). He insists that science is not a halfway game; there are few halfway right answers, so, he will only allow students to move ahead to the next section of a paper after the previous section has been approved—and the baseline for approval is the grade of A. So, students who do not satisfactorily complete a section of the paper receive a zero. The only possible grades on any writing assignment are zero or A. While such a grading scheme may seem draconian, students have responded well to the challenge. Failures in his class are rare.

Part of his secret is that he encourages students to get help from peers and other adults as well as through his frequent mini-conferences in class. Not only do the students learn to write well, he claims that he never takes a paper home to grade.

VALID AND RELIABLE ASSESSMENT

One of the truths about writing in science is that it substantially limits the amount of insincere blather (also known as bullshit) that can emanate from the mind of a student when he/she has absolutely no idea about a correct response. A student who does not have a basic understanding of scientific theories will have immense difficulty in applying them. In responding to an authentic scientific problem through an essay, there is no way to "luck out" on a guess at the correct answer; there is no place to hide. In general, essays that require students to invoke pertinent scientific principles and theories and to explore potential applications are more genuine assessments of student knowledge than objective tests of short queries paired with possible answers already furnished.

Another advantage of writing essays is that the teacher can get a sense of where student comprehension is strong and where understanding begins to break down. After all, writing is a form of concretized thought. Thus, when a student's grasp of a concept begins to get off-track, it is only through those moments when thought is made visible that a teacher is able to identify the problem and provide help. Writing provides the opportunity for the kind of intervention that can prevent conceptual misunderstandings that can haunt a student for his entire academic career. Indeed, Heddy & Sinatra (2013) and Francek (2013) have found that one of the most difficult areas of teaching is trying to get students to un-learn a misconception.

MYSTERY ASSESSMENTS

Imagine taking a team of students to a science fair, then having the judges of the competition change the criteria on which projects were to be judged after your team arrives. Then, ten minutes later, the judges decide to alter their scoring rubric again, though they refuse to reveal how the criteria have changed or even what new criteria might be used. The response of most teachers would be total frustration and a pledge to never again enter any students into this particular science fair competition.

Unfortunately, many science teachers utilize a similar kind of "mystery evaluation system" as a matter of course in their classes. Too often, students do not understand the criteria upon which they are to be graded before they undertake a project. Unfortunately, students do not have the option of choosing another science fair. Instead, they must accept whatever system the teacher decides to adopt, even if it may be invalid, unreliable, and amorphous.

The moral is that the criteria upon which a particular assignment will be assessed should be given to students when making the assignment—not revealed to them afterwards. What is important? What is superfluous? What should the student be able to do upon completion of the assignment? What is the purpose? Framing an assignment by revealing the criteria by which it will be graded helps students know where to focus their energies.

Indeed, one of the most effective approaches to improve the quality of writing is to identify the characteristics of good writing and insert them into the evaluation. In this manner, students who write to get a high grade actualize the desired effective strategies to do so. In the parlance of some composition studies (Hillocks, 1986, 2011), such an approach to writing is sometimes called *scalar* because the grading scale helps direct student effort.

Once a student knows what is expected, the probability that their eventual academic efforts will approximate the desired result is infinitely greater than when writing under a mysterious grading rubric.

THE CRITERIA FOR WRITING ASSESSMENTS

The NAEP (National Assessment of Educational Progress), who has been evaluating the writing of American students since 1969 (Stedman, 2009), suggests basic criteria for making writing assignments. A teacher should specify TAP—Topic, Audience, and Purpose—for most formal writing assignments. The topic should address" real-world, age-appropriate, and grade-appropriate issues" (National Assessment Governing Board, 2010, p. 6) and be open enough to allow for some student choice and the exercise of creativity.

The audience should be specified for every assignment as well and should also be age-appropriate and familiar enough to students so that they can organize their papers accordingly. For example, having students prepare papers for a professional group of phlebotomists, members of medical laboratory teams who collect and transport laboratory specimens, may not be appropriate because students would be uncertain of the plebotanist's daily work and possible frames of reference. However, designating a "general audience" that includes peers, parents, and other adults interested in health issues would be fair and appropriate.

The NAEP uses a set of basic criteria to score essays, with elaborations that vary with TAP (topic, audience, purpose).

Figure 9. NAEP Basic Criteria (National Assessment Governing Board, 2010)

I. Idea development (in relation to TAP)
- Depth and complexity
- Details
- Examples
- Effectiveness

II. Organization (in relation to TAP)
- Structure
- Coherence
- Focus
- Transitions

III. Mastery of the language (in relation to TAP)
- Sentence structure and variety
- Word choice
- Voice and tone
- Grammar, mechanics, usage

Six-point grading scale

The typical NAEP evaluation tool ranks student writing on a scale from 0 to 6, with 0 meaning that the student turned in a blank page and a 6 representing the highest possible score. The easiest way to translate NAEP scores for the traditional grading scale is as follows:

6=A
5=B
4=C
3=D+
2=D-
1=F

The lowest possible passing score is a 4, sufficient. Scores of 3, 2, or 1 are failing in that the writing does not meet a minimum standard. Sometimes, the NAEP presents results using the following scale:

Advanced
Proficient
Basic
Below basic

The logical letter grade correlation to each category is:

Advanced=A
Proficient=B
Basic=C
Below basic=D or F

The six-point scale is preferable to a four-point scale because it provides more information for students who need it the most—those scoring 1, 2, and 3. A student who scores a 3 on an assignment may be centimeters from a passing score, whereas a student who scores a 1 could be light years away from a passing score. A four-point scale places the student who scores a 3 in the same category as the student who scores a 1—"below basic." Students who fail to meet the minimum standard need to know precisely what they need to do to bring the quality of their writing up to a passing score.

HOW TO SCORE WRITING

If you were going to be trained to score writing for NAEP, you would be placed into a group and given the criteria for scoring a specific kind of writing. Following a discussion of the criteria, you would receive sample papers at each level, from A-F (or 6 to zero). These are called *benchmark* papers and are used to help make decisions for subsequent papers.

Then, you would receive a stack of papers to score. After you read a paper, you would place it in a pile of papers you think deserve a similar score. After you have placed all papers in the appropriate piles, A, B, C, D+, D-, and F, you would check to see how well your assessments align with other members in the group. If all of your assessments align well, then you would be allowed to continue to score papers for the NAEP. If one of your scores differed from the group by 1 point, that is, if you scored a paper an A-level, but everyone else scored it at the B-level, you would discuss the differences with the group leader and would be placed "on probation." If your scores eventually aligned with the group, then you would remain an NAEP scorer. If your scores continued to vary by a point, you would be let go.

If your score differed from the group by two levels, that is, if you scored a paper as an A-level, but everyone else scored it at the C-level, you would be dismissed.

The holistic method of scoring works well for most teachers as they have no problem distinguishing an A from a C or an F. The strength of the holistic approach is that it insures consistency, but also allows the teacher to focus on primary traits, or specific characteristics. When writing is assigned, strongly consider whether or not it needs to be graded. Most writing can be quickly scanned and given a ✓ (check mark) based upon completion. When an assignment needs to be graded, a holistic, primary-trait scoring format that utilizes a 6-point scale is recommended.

Three formal, level 3 rating scales for persuasive, narrative, and informational writing follow.

Figure 10. Rating scale for persuasive writing (NAEP, 2000), level 3

A=Excellent Takes a clear position and supports it consistently with well-chosen reasons and/or examples; may use persuasive strategy to convey an argument. Is focused and well organized, with effective use of transitions. Consistently exhibits variety in sentence structure and precision in word choice. Errors in grammar, spelling, and punctuation are few and do not interfere with understanding.
B=Skillful Takes a clear position and supports it with pertinent reasons and/or examples through much of the response. Is well organized, but may lack some transitions. Exhibits some variety in sentence structure and uses good word choice; occasionally, words may be used inaccurately. Errors in grammar, spelling, and punctuation do not interfere with understanding.
C=Sufficient Takes a clear position and supports it with some pertinent reasons and/or examples; there is some development. Is generally organized, but has few or no transitions among parts. Sentence structure may be simple and unvaried; word choice is mostly accurate. Errors in grammar, spelling, and punctuation do not interfere with understanding.
D+=Uneven (may be characterized by one or more of the following:) Takes a position and provides uneven support; may lack development in parts or be repetitive OR response is no more than a well-written beginning. Is organized in parts of the response; other parts are disjointed and/or lack transitions. Exhibits uneven control over sentence boundaries and sentence structure; may exhibit some inaccurate word choices. Errors in grammar, spelling, and punctuation sometimes interfere with understanding.
D-=Insufficient (may be characterized by one or more of the following:) Takes a position but is very undeveloped. Is disorganized or unfocused in much of the response OR clear but very brief. Minimal control over sentence boundaries and sentence structure; word choice may often be inaccurate. Errors in grammar, spelling, and punctuation interfere with understanding in much of the response.
F=Unsatisfactory (may be characterized by one or more of the following:) Attempts to take a position (addresses topic) but position is very unclear OR takes a position, but provides minimal or no support; may only paraphrase the prompt. Exhibits little or no apparent organization. Minimal or no control over sentence boundaries and sentence structure; word choice may be inaccurate in much or all of the response. Errors in grammar, spelling, and punctuation severely impede understanding across the response.

Figure 11. Rating scale for narrative writing (NAEP, 1999), level 3

A=Excellent Tells a clear story that is consistently well-developed and detailed; details enhance story being told. Well organized; integrates narrative events into a smooth telling; effective transitions move the story forward. Consistently exhibits variety in sentence structure and precision in word choice. Errors in grammar, spelling, and punctuation are few and do not interfere with understanding.
B=Skillful Tells a clear story that is well-developed and supported with pertinent details in much of the response. Well organized with story elements connected across most of the response; may have occasional lapses in transitions. Exhibits some variety in sentence structure and uses good word choice; occasionally, words may be used inaccurately. Errors in grammar, spelling, and punctuation do not interfere with understanding.
C=Sufficient Tells a clear story that is developed with some pertinent details. Generally organized, but transitions between parts of the story may be lacking. Sentence structure may be simple and unvaried; word choice is mostly accurate. Errors in grammar, spelling, and punctuation do not interfere with understanding.
D+=Uneven (may be characterized by one or more of the following:) Tells a story that may be clear and developed in parts; other parts are unfocused, repetitive, or minimally developed, OR is no more than a well-written beginning. Organized in parts of the response; other parts are disjointed or lack transitions. Exhibits uneven control over sentence boundaries and sentence structure; may exhibit some inaccurate word choices. Errors in grammar, spelling, and punctuation sometimes interfere with understanding.
D-=Insufficient (may be characterized by one or more of the following:) Attempts to tell a story, but is very undeveloped, listlike, or fragmentary. Disorganized or unfocused in much of the response, OR the response is too brief to detect organization. Minimal control over sentence boundaries and sentence structure; word choice may often be inaccurate. Errors in grammar, spelling, and punctuation interfere with understanding in much of the response.
F=Unsatisfactory (may be characterized by one or more of the following:) Responds to prompt but provides little or no coherent content, OR merely paraphrases the prompt. Little or no apparent organization. Minimal or no control over sentence boundaries and sentence structure; word choice may be inaccurate in much or all of the response. Errors in grammar, spelling, and punctuation severely impede understanding across the response.

Figure 12. Rating scale for informative writing (NAEP, 1999), level 3

A=Excellent Information is presented effectively and consistently supported with well-chosen details. Focused and well organized, with a sustained controlling idea and effective use of transitions. Consistently exhibits variety in sentence structure and precision in word choice; word choice enhances understanding. Errors in grammar, spelling, and punctuation are few and do not interfere with understanding.
B=Skillful Information is presented clearly and supported with pertinent details in much of the response. Well organized, but may lack some transitions. Exhibits some variety in sentence structure and uses good word choice. Errors in grammar, spelling, and punctuation do not interfere with understanding.
C=Sufficient Information is presented clearly and supported with some pertinent details. Generally organized, but has few or no transitions between parts. Sentence structure may be simple and unvaried; word choice is mostly accurate. Errors in grammar, spelling, and punctuation do not interfere with understanding.
D+=Uneven (may be characterized by one or more of the following:) Information is presented clearly in parts; other parts are undeveloped or repetitive, OR is no more than a well-written beginning. Organized in parts of the response; other parts are disjointed or lack transitions. Exhibits uneven control over sentence boundaries and sentence structure; may exhibit some inaccurate word choices. Errors in grammar, spelling, and punctuation sometimes interfere with understanding.
D-=Insufficient (may be characterized by one or more of the following:) Provides information that is very undeveloped or listlike. Disorganized or unfocused in much of the response, OR is too brief to detect organization. Minimal control over sentence boundaries and sentence structure; word choice may often be inaccurate. Errors in grammar, spelling, and punctuation interfere with understanding in much of the response.
F=Unsatisfactory (may be characterized by one or more of the following:) Responds to prompt but may be incoherent, OR provides very minimal information, OR merely paraphrases the prompt. Little or no apparent organization. Minimal or no control over sentence boundaries and sentence structure; word choice may be inaccurate in much or all of the response. Errors in grammar, spelling, and punctuation severely impede understanding across the response.