Mars in Our Imagination:
Fostering Critical Literacy Across Content Areas

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INSPIRATION

Prior to last year's election, I tended to avoid reading non-fiction. Having just completed my Master's degree, I thought I had my fill of research studies, theoretical works, and peer-reviewed journals. I preferred to read as an escape. Long plane rides were easily tolerated with a work of historical fiction or a thought-provoking novel. Few of the current non-fiction titles being aggressively marketed (investigations into the sins of the President or obfuscations of the opposing candidate) held much interest for me. Up until June of 2004, I enjoyed the editorial pages of the *New York Times*, and was easily animated by good-natured debates with close friends, but being fairly secure in my political beliefs and attitude, I didn't feel like I needed to learn much more to make a decision at the ballot box.

As the election heated up and the more ample leisure time of summer break allowed, I found time to wander around the Internet. I discovered the latest innovation in communication: the weblog, or as more popularly known, the blog. A blog is an electronic diary or journal. Anyone can create one and anyone can read the intimate thoughts or strident opinions of its author. The author, or blogger, can include hyperlinks within the text to link to another document on the World Wide Web. As a blogger presents his or her argument, position, or as is more often the case, accusation, he or she can link to a document that supports the argument. Readers can then post comments to the blog; thus, a network of hundreds of thousands of readers and bloggers hold rich, vibrant, and emotional conversations.

I was utterly enthralled. Whole afternoons would disappear as I followed one blog to another to a series of articles and back. Erudite professors, middle-eastern experts, passionate journalists, and superstitious conspiracy theorists became the authors I followed. Suddenly, I was totally absorbed in a kind of text that until that time I considered dull. Constantly uncovering bias and manipulation across a variety of politically charged subjects, I was daily engaged with material previously thought to be boring. I also found myself questioning some deeply held beliefs as a result. I realized how important it was to educate oneself with as much objective information as possible when determining the value of any particular national, state or local policy.

One of the most common epithets I read on the Democratic blogs was a profanity-laced quote from a skit by comedian Dave Chappelle. It satirized George W. Bush's desire that funds be directed to a Mars exploration program. Since I generally shared the bewilderment of the bloggers who poked fun at this policy, it meant little to me until my seminar leader made a comment about his frustration with the level of science literacy in the country. "People don't know enough about space exploration to determine whether the President's plan to go to Mars makes sense or is absolute insanity." Wait a minute. Going to Mars might be a good thing while we're waging a major war? He may not have been talking about national priorities, but it did occur to me that space exploration had netted benefits to those of us on earth. I was also reminded of the authoritative positions taken by a geneticist friend of mine, a Ph.D. scientist working in breast cancer research at M.D. Anderson. I trusted his opinions on bioengineering and

the politics surrounding it. He made convincing arguments for genetically modified food and again bemoaned the general population's inability to truly have an informed debate over policies with scientifically proven benefits.

Scientists are highly concerned with the lack of science literacy because of their concern about the impact on public policy. Literacy, in general, is not simply being able to read the words, but the ability to usefully understand the concepts the words construct. Science literacy goes further than understanding terminology, but includes certain "habits of mind" assumed to be part of scientific reasoning and discussion. If individuals are unable to understand the basic concepts, common terms and dispositions underlying scientific developments, they will not be able to evaluate the benefits or ills such a development might bring. They are left beholden to partisans or interest groups hoping to manipulate their viewpoint. Although this is the concern voiced by scientists and science educators, it is also one that concerns English educators as well. Frequently, when an English teacher says that a student "can't read," it is more about a lack of critical reading skills and "habits of mind" and less about just reading the words. I thought about my reading of the blogs and knew my students did not have the disposition of skepticism that I did. I am acutely concerned of their gullibility in this respect.

As I conducted my preliminary research for this unit, I came upon an intriguing set of educational benchmarks created by the American Association for the Advancement of Science through its *Project 2061*. The introduction included:

> Project 2061 promotes literacy in science, mathematics, and technology in order to help people live interesting, responsible, and productive lives. In a culture increasingly pervaded by science, mathematics, and technology, science literacy requires understanding and habits of mind that enable citizens to grasp what those enterprises are up to, to make some sense of how the natural and designed worlds work, to think critically and independently, to recognize and weigh alternative explanations of events and design trade-offs, and to deal sensibly with problems that involve evidence, numbers, patterns, logical arguments, and uncertainties.

I was startled by the commonalities between the aims of the AAAS benchmarks and some of the English objectives in the Texas Essential Knowledge and Skills (TEKS). Additionally, having looked at the science objectives found in the TEKS, I sensed it was one of the "overstuffed curriculum[s] that placed a premium on the ability to commit terms, algorithms, and generalizations to short-term memory and impede[d] the acquisition of understanding" that Project 2061 warned us against (AAAS *Project 2061 Benchmarks*). I recognized an opportunity to simultaneously serve my students in their acquisition of English as well as their ability to critically think about science and technology.

INSTRUCTIONAL APPROACH

This past school year, the English I team at Lee High School taught a series of units developed with a preponderance of expository or non-fiction texts. The curriculum was interdisciplinary. It required students to go beyond the domain of fictional literature to fully grasp the curriculum's subjects: the heroism and relevance of Nelson Mandela, the intrigue of the city of New Orleans, or the remarkable and technological feat of climbing Mount Everest. As Literacy Coach, I supported the group of teachers and reflected with them on the efficacy of the instructional strategies. What struck me most about the instructional approach was the insistence that the students be *lured* into reading and learning. Rather than the traditional approach of presenting information and asking questions, *the students* were expected to ask the questions. One of the reasons I

discovered blogs was curiosity. A blogger would make a controversial or funny comment, and I would be hooked into hours of investigation and learning. The units tended to mimic this very effect with a tease in the form of an engaging passage or short clip of a video. Students would be charged with asking as many genuine questions as possible. These questions would be placed on a chart that would remain in the room throughout the course of the unit. Each day more and more information would be presented, and as the students were given various reading and thinking tasks, they would find their questions answered. The methods of the curriculum coincided with the important conclusions that both astute educators and brain researchers come to: emotions must be engaged in order for students to truly learn (Jensen 78-80) or, in other words, students – especially young adults – will learn what they *want* to learn. Out of necessity and personal desire, the instructional strategies used in Lee High School's literacy program will be the foundation of this curriculum unit.

One of my colleagues taught in a small learning community that was overwhelmingly populated by boys. He was effusive in his praise for the curriculum. I theorized that the boys found themselves a role model in Nelson Mandela and may have been perplexed and fascinated by those who would climb the highest mountain in the world. This was meaningful to me in that an additional concern of mine was the accessibility of texts to male adolescents. There is a growing body of research dedicated to the literacy needs of male students. In general, they are less engaged with the narrative and literary texts of the traditional English class. They are more drawn to informational or non-fiction texts that deal with subjects of personal interest (Brozo 17). Next year, I am likely to teach in the Applied Engineering small learning community, with a similar imbalance in the male to female student ratio. With an annual trip to the Johnson Space Center, it would be natural for me to construct a literacy unit based around a subject of higher interest to these students: Mars.

MARS AND THE HUMAN IMAGINATION

Mars is one of the more engaging planets in our solar system. It brilliance, its russet hue, and its peculiar movement in the night sky lured humans into worship and speculation. Beyond our visit to the moon, it is considered the next plausible stop for manned space flight. As previously mentioned, it was a subject of presidential concern. The history of humanity's engagement with this planet is far-reaching, from the ancient Assyrian prognostications, to today's blockbuster remake of H.G. Wells' *War of the Worlds*. Recent geological and biological investigations have suggested that *some* form of life exists or had existed there. Between its history and its future, Mars is a rich source for investigation, discovery, and learning.

OVERVIEW OF INSTRUCTIONAL STRATEGIES

The Read Aloud and the KWL Chart

The Read Aloud (Serafini and Giorgis 1) strategy is a simple, yet powerful strategy. The Read Aloud in the secondary classroom is accomplished with a set of short, powerful texts. The text can be projected on a screen and/or provided to the students. The teacher reads each passage aloud and can then follow up with any number of activities. At the beginning of the unit, the Real Aloud often functions as the hook – it piques the interest of the students. Frequently the first Read Aloud is followed with the teacher asking the students to generate as many questions they can muster about the topic of the passage. The teacher collects these student-generated questions and posts them on a KWL chart (what you **K**now, what you **W**ant to know, and what you **L**earned) under the "W" column (Vacca and Vacca 211). Another Read Aloud might provide the students with vital background knowledge, and the teacher may prompt students to list what they already know of the subjects as well as listing any answers already provided by the Read Aloud. Other exercises which the teacher can ask of the students is to answer an interpretive prompt

following the Read Aloud, to predict what the next passage might be about, to sketch a drawing representing the meaning of the passage, to identify words which are unfamiliar to them and require defining, to mimic the style of the writer of the passage in a new passage, to summarize the passage, or to chart the information from the text into a graphic organizer. The possibilities are numerous.

The instructional aim of the Read Aloud is to provide a struggling reader with a good model of reading. It demonstrates accurate pronunciation of words outside of the learner's oral vocabulary. It demonstrates prosody, or the articulation of a passage that considers punctuation and meaning, rather than a monotonous reading showing lack of comprehension. It also gives access to necessary information and background knowledge that students might not be able to unlock for themselves (Serafini and Giorgis 1-2, 8-11).

The KWL chart is a vital tool that allows the students to monitor their learning. It provides a visual resource that identifies what they know and what they need to know. Used in conjunction with the Read Aloud, it helps the learner discover the instrumentality of reading. They identify what they want to learn and find that their reading allows them to learn it (Vacca and Vacca 211; Daniels and Zemelman 106).

The KWL chart can be further developed using brief video clips, and from reading activities described below. Throughout the unit the list of questions and answers grow and grow. Towards the end of the unit, it is an impressive representation of what the students accomplished with their own curiosity and investigation.

The Word Splash, the Vocabulary Knowledge Chart

After the initial Read Alouds, the teacher will likely want to address specialized vocabulary that will surface over the course of the unit. Some vocabulary might have already been identified from a previous Read Aloud prompt. The vocabulary is projected or posted in the room in the form of a "splash." The students are prompted to try to determine the meaning of as many words as possible without using a glossary. The teacher can demonstrate structural analysis, or the breaking down of words into meaningful parts and hypothesizing a meaning. With scientific language, structural analysis is a key strategy for determining the meaning of words (e.g "hydro" = water, "philic"= love of; therefore, hydrophilic is "love of water.") The students would then be furnished with a vocabulary knowledge chart where they identify their level of knowledge: have they seen the word, can they define the word, and can they use it in a sentence? (Beers 179-188)

Explicit instruction is necessary with specialized vocabulary in which context cannot help the reader determine the meaning. Students will create note cards depicting the meaning of these words to assist them in further readings within the unit.

The Think Aloud

The Think Aloud (Tovani 26, Beers 42-43) is similar to the Read Aloud except for a key action on the part of the teacher. With a Think Aloud, as the teacher reads, she stops and reports what her mind is doing to construct meaning. She might pause and explain how she is forming a picture in her mind or visualizing the subject. She might sketch a diagram in the margin showing the process or sequence of events being discussed. She might stop and ask a question about the text. She might reflect on how she had heard or seen something similar – in another book, on TV, or in a movie. She will comment about how the reading affects her emotionally. She will demonstrate re-reading when she doesn't understand what she read. She will demonstrate figuring out the meaning of an unfamiliar word using the context. The students will take notes with her, learning that building comprehension is an active process.

Texts useful for the Think Aloud strategy will be dense with meaning. They will likely be more technical in nature, or they might have been written in an unusual style that requires more work on the part of the reader. With scientific texts, the Think Aloud is an absolutely necessity. Students will need to see and hear the teacher's thinking repeatedly with texts requiring considerable background knowledge such as a textbook or a more sophisticated article.

The Think Aloud will also be key in helping students see that not everything that is read should be believed or that authors sometimes leave out important qualifiers. With articles meant for popular consumption, the teacher can highlight misleading prose, bias, or underlying assumptions.

Sequencing

Sequencing is another simple yet powerful activity that helps students think about their thinking. Here, the teacher scrambles the sentences of a passage, cuts them into separate strips, and charges the students with reconstructing it. Once the students have put the text back together, they must justify their reasoning by pointing to clues in the text or explaining how the text wouldn't make sense any other way. This is a very popular activity with students as they enjoy its puzzle-like quality. The purpose of the activity is to alert students to text structure, thus supporting meaning making (Vacca and Vacca 252)

Initially, texts that describe action and specific linear events are the best choice for this kind of activity. Once the sequencing has been completed, information from the passage can be used in answering questions from the KWL chart or in a further instructional activity.

The Inductive Model

The Inductive Model was first conceived by a social studies educator, Hilda Taba, in the 1950s (Joyce and Weil 116-117). Its purpose was to help students develop concepts through the thinking skills of classification and categorization. Students are given a set of "data" to read, usually a series of approximately 24 short passages. They then classify each passage according to the main idea. Once classified, students group passages into larger categories. From these categories they are able to connect discreet information into a larger concept. The "data" can be used in conjunction with graphic organizers such as a Venn diagram (to compare and contrast); a concept web; and a t-chart representing costs and benefits, fact and opinion, or cause and effect. It is an extremely flexible activity that lends itself to virtually any subject matter. It is a necessary activity in that it truly is an active, higher-order thinking activity for the learner.

UNIT OVERVIEW

The purpose of the unit is not to provide explicit instruction of specific scientific objectives. In terms of pure academics, its purpose is to bolster students' reading abilities with critical comprehension skills such as questioning, prediction, sequencing, and concept formation. It hopes to provide students with the schema required to allow them to pursue independent academic projects involving research and analysis. An ulterior objective is to reposition intellectual work as valuable in and of itself. With thinking and reading skills, students are more than just prepared to enter the workforce; they will appreciate inquiry as a uniquely human endeavor. The study of Mars is an incredibly fertile subject that lends itself to extensive investigation in the areas of astronomy, geology, geography, chemistry, philosophy, history, and literature. A four to five week unit can hardly do it justice. Rather, the unit is meant to merely open the students' eyes to the possibilities of intellectual and scientific inquiry and curiosity, not to create expertise on any one particular subset of the topic.

Students will practice the skills of observation and analysis of images, words, and texts. They will generate their own questions regarding the planet, then pursue, through reading, the answers

to their questions. They will learn of the place Mars had in the imaginations of ancient peoples, as well as how its retrograde orbit challenged and inspired early astronomers such as Kepler. Students will understand how new information must necessarily replace old with the "canali" proposed by Schiaparelli and championed as evidence of intelligent life on Mars by Percival Lowell. From Lowell's theories, they will recognize the allure and dramatic potential of Mars through the lens of popular culture: reading excerpts of Edgar Rice Burroughs' *A Princess of Mars*, then hearing Welles' broadcast of *War of the Worlds*. Current myths about Mars will then be explored, namely, "The Face" on Mars. In considering these media, students should gain some skepticism when interacting with material that suggests conspiracy theories.

Moving back into the non-fiction world, they will discover the mindset and personalities of contemporary individuals who have made the study of Mars their life's work. The science of Mars exploration will be addressed through comparisons of Mars to Earth in its geology, atmosphere, and to some degree, its known chemical composition. Certainly instructional time will be devoted to investigating the importance of water on Mars and the question of life on Mars. The technical aspect of Mars exploration will be briefly ascertained through information on the successes and failures of recent Mars missions. Ultimately, students will be asked to apply their new knowledge of Mars in written form, where they identify an area that particularly intrigued them, pursue additional research, and compose an expository essay.

Introduction of the Unit

The unit begins with students examining the "text" of images of the surface of Mars: its rocky, desert-like floor and a topographical map indicating caverns, canyons, and possible river beds (see appendix). They are not told what they are looking at, but are asked to make predictions or guesses, and the guesses are posted. A new set of images of the planet photographed from space are presented, however, they are asked to generate questions about the image. Some students may recognize it as Mars, but their predictions are not yet confirmed or denied. Frequently, students are not expected to ask the questions, and this task might begin laboriously. It might be necessary to push and prompt the students to generate as many questions as possible. "What is that?" will need to be developed into "what is that dark spot covering most of the surface?" Anticipated questions might be: how far away is it? how big is it? how did we get those pictures? has a person ever gone there? does life exist there? As students respond with questions, they are collected and placed prominently in the classroom on a KWL chart under the "W." Throughout the remainder of the unit, whenever information is presented in the class which answers one of the posted questions, students will be encouraged to complete the column labeled "L" for "what they learned."

Next, the students are presented with a short passage to consider. Up until this point, the topic of the unit is not completely clear. With this passage the topic is confirmed:

> When well placed, Mars is the brightest object in the entire sky apart from the Sun, the Moon and Venus. It stands out not only because of its brilliance, but also because of the strong red colour which led the ancients to name it in honour of the God of War. Now and then, it has even caused general alarm, as it did in 1719, when it was at its very best and many people mistook it for a red comet which was about to collide with the Earth. At its faintest it is not much brighter than the Pole Star, and at such times it is not easy for the beginner to identify it. (Moore 20)

Students will then write to a prompt using the metaphor of Mars' "brilliance": where and when have you encountered Mars?

Mars in Antiquity

> Unfortunate Mars! What evil fairy presided at his birth? From antiquity, all curses seem to have fallen upon him. He is the god of war and carnage, the protector of armies, the inspirer of hatred among the peoples, it is he who pours out the blood of humanity in hecatombs of the nations. (Camille Flammarion in Sheehan and O'Meara 47)

Students should recognize that observation of the heavens may very well be the original science. Ancient peoples looked up to the skies and generated ideas, primarily religious beliefs, around the movement of the heavenly bodies in the night sky. Australian Aborigines, ancient Egyptians and Indians, as well as the Babylonians, Persians, and Greeks studied the movements of the stars and planets and formulated astrologically based belief systems (as well as calendars!). Mars, with its characteristic hue, inspired particular attention and poeticism (Sheehan and O'Meara 43-48). A brief investigation of this characteristic will provide students with a conceptualization of early thought in ancient societies.

For this portion of the unit, students will first consider the color red and its symbolism. A quick write will reveal the students' initial orientation towards the color, then a further discussion around the meaning red conveys in many cultures. It symbolizes love, yearning, and happiness; yet, as the color of blood, it symbolizes anger, warfare, and carnage. After the initial discussion, a short series of passages are presented to the students, which range from the poetic to the scientific, discussing the color red. Students will discover the psychological trigger red represents, that it is the third color visible to the human eye after black and white, its prevalence in the animal kingdom, and its use in marketing (Sheehan and O'Meara 48). Given the information from the passages, students are then asked to write about how ancient peoples may have reacted and responded to the red planet.

The next activity will focus on the retrograde orbit of the planet. Mars moves from west to east, but stops at a peak. It then appears to move backwards for a spell, again stops, and returns to its original easterly path. Its orbit is an ellipse, thus its relative brightness changes according to its position vis-à-vis the sun (Moore 20-21). After a brief physical demonstration of this phenomenon using manipulatives, students will read short passages from ancient texts to further their understanding of the astrological basis of ancient thought. These passages declare "When Mars culminates and becomes brilliant, the king of Elam will die. When the god Nirgal in its disappearing grows smaller, like the stars of heaven is very indistinct, he will have mercy on Akkad" (Sheehan and O'Meara 49; Bone 12-13). They return to their writing and add to their understanding of how Mars inspired the ancients.

Mars and the Scientific Revolution

Patrick Moore asserts that Mars' orbital eccentricity and general "conspicuousness" allowed Johannes Kepler to finally break the superstition of an earth-centered universe and the unhelpful notion of circular orbits. Kepler was able to determine that Mars' orbit was elliptical rather than circular. Up until his discovery, astronomers held fast to the idea that the planets maintained "perfect" circular orbits. As a result, it had been difficult to mathematically prove the Copernican theory of a sun-centered planetary system given Mars' strange behavior. With Kepler's contribution, according to Moore, "the main battle was over" and Kepler "had provided the vital evidence" (19).

For this portion of the unit, the students will complete two "puzzles," a cloze passage and a sequencing activity. A passage containing a description of Mars' orbit will have words eliminated and the students must work on completing the passage. Their prior knowledge of the phenomenon will assist them in determining what words are missing. Next, the students will be

given scrambled pieces of a text describing the establishment of the heliocentric theory, and the students will need to sequence this information according to the correct timeline.

Mars Misunderstandings

"Its part of the nature of man to start with romance and build to reality"
~ Ray Bradbury (in Sheehan and O'Meara 113)

Students will have another opportunity to consider the concept that scientific knowledge and discovery is routinely challenged, evaluated and re-assessed. Theories are tested and discarded when proven untrue. Furthermore, scientific ideas are easily contorted without the benefit of expertise, and the public can be duped for wont of accurate information.

In the late 19th century, a group of astronomers were seeking to map the topography of Mars with the use of powerful telescopes. One such astronomer, Giovanni Virginio Schiaparelli, was far and away the most successful and hence influential in imprinting Mars with a nomenclature that remains in use today (Moore 50, Morten 21). His observations and drawings detailed a network of *canali*, or canals. The canals appeared to be very regular, following a pattern, and continuous. Other astronomers, namely Percival Lowell, grasped on to the potential of these canals as having been artificially built by a Martian civilization in need of an extensive irrigation system (Bone 13, Sheehan and O'Meara 132; Moore 54-55). The very idea of a network of canals was debated, and with it the idea that intelligent life on Mars existed. Tests via comparison of different observer's sketches suggested that the canals were indeed in the eye of the beholder. With the conclusive observations of Eugenios Antoniadi during the late 1920s with more powerful observation tools, the canals were indeed revealed to be illusory (Moore 58-59; Sheehan and O'Meara 174).

Even though the idea of a Martian civilization had been effectively debunked amongst many in the scientific community, new technology nonetheless spurred the public's imagination. The invention of the radio and claims that Mars was signaling the earth made headlines. Authors of a new genre of literature, science fiction, such as H.G. Wells and Edgar Rice Burroughs, were considered the "experts" to be consulted rather than the scientists who knew otherwise. The thought that an advanced civilization existed on Mars was surprisingly acceptable to the public's mind as well, as the panic caused by Orson Welles' dramatization of *War of the Worlds* indicated (Sheehan and O'Meara 202-203; Bone 15-16).

Prior to engaging with this content, students will need to briefly discuss the idea of canals, and what they represent. Then, they will need to wrestle with how astronomers could study Mars without the aid of a space craft and digital cameras. The telescope will generally be discussed. Primary source material will again be used, including Schiaparelli's notes on the canals, pictures of his sketches, and then Lowell's discussion of the canals and possible signs of intelligent life. Students will examine these documents and draw out conclusions regarding what the canals were and what they meant. They will discuss the difference between natural and artificial canals. Finally, the work of Antoniadi will be presented.

To invest students with the notion of public gullibility, students will interact with a variety of media. They will examine the headlines proclaiming the reception of radio signals from Mars, consider the "expertise" of individuals like Edgar Rice Burroughs on scientific matters, and they will hear a portion of *War of the Worlds*. They will then consider the apology put forth by CBS in the aftermath of the panic.

This will transition nicely into a discussion of "The Face" on Mars purported to be evidence of an advanced civilization. Philip Plait, also known as the "Bad Astronomer," goes to some length to discredit the conspiracy theorist, Richard Hoagland, who heralded the phenomenon as proof of life on Mars. The story of the face on Mars is similar to the canals: a photographic

image of a canyon on the surface of Mars suggests a face-like appearance. Hoagland argues that the face is of artificial origin and indicates an engineering feat of an intelligent society. A photograph with better resolution and at closer range shows that "the face" was a trick of light and shade. Students will examine the websites of both Plait and Hoagland, along with the two photographs of "the face" (Plait *Richard Hoagland's Nonsense;* Bone 14-15*).* Discussion and writing about what makes media "legitimate" would follow.

Modern Day Mars

The current mission of NASA's Mars Exploration Program is stated as follows: "Determine if life ever arose on Mars, characterize the climate of Mars, characterize the geology of Mars, and prepare for human exploration of Mars." (*NASA's Mars Exploration Program's Science Theme*). The mission appears to be an overwhelmingly intellectual enterprise whose aims are to satisfy human curiosity and expand human knowledge. Any materialistic purpose is hidden by these simple statements, which might raise some interesting questions in the minds of students.

Work in our society, and in particular to individuals in the working or lower income classes, is a matter of wage earning and financial gain. It is not, generally, a means of self-actualization or done for purely abstract purposes, such as the advancement of knowledge. The climate of the typical high school moreover, reinforces the idea that students are being prepared for gainful employment, not intellectual development. The kind of instruction typically found in the ninth grade courses of world geography, physical science, English, and algebra tends to be unrecognizable as preparation for work to many students. Ironically, the staid and traditional methods of instruction in high schools do not guarantee the development of skills now demanded by employers either: creative problem-solving, strong communication skills, and the ability to collaborate.

Now ask a teacher in many schools about what they hope their students will become and the cliché "life-long learner" will eventually assert itself. Little in the students' experience with school, however, can support this objective. Present students with descriptions of NASA researchers or Jet Propulsion Lab (JPL) engineers and they might find a model of such a learner. Scientists at NASA and at JPL work for the government, thus their remunerative potential is limited by how much Congress allows for their projects. Although their compensation is similar, they frequently work six days a week, year-round, without the perks other academics receive such as sabbaticals and summers off. Their salaries most certainly do not match those in the private sector (Bergreen 9). Clearly, they are far more motivated by learning and discovery. Students would have gotten a taste of this orientation when reading the words of Schiaparelli or Lowell, but in reading the life stories of some of the contemporary personalities now pursuing Mars, such as Jim Gavin, it will be hard to ignore:

> In the heyday of the Apollo program, NASA was thinking seriously about sending people to Mars, yet the agency hesitated. Guiding a robotic spacecraft to the Red Planet is an intricate, ambitious, and unpredictable undertaking; a human mission would be far more risky and complex. NASA was stymied by the problem of getting its astronauts home. Jim came up with a unique solution: he offered to go to Mars on a one-way basis…[Jim explained] 'The only way you could get a man there was one way. It would be too costly to get him back to Earth. So I would go there, have enough life support to explore and survive for two years, and then…That would be all. And it would have been worth it, the scientific returns would have been spectacular.' (Bergreen 12-13)

Students will be introduced to a modified version of the inductive model while studying these "alien" personalities. Short passages that illustrate the characters of Jim Gavin, David McKay, Kathy Thomas-Keprta, and Jennifer Harris, will be listed. The pre-determined categories will be

what the individual said, what they did, how they thought, and how others saw them. Quotes, writings, and anecdotes will gradually fill out an image of each of these individuals. Within each short passage, glimpses of the discoveries and advances they have made will be revealed. Upon completion of the categorization and classification of these characters, students will formulate conclusions regarding the attributes required for a scientific vocation. Students will finish the activity with a writing assignment akin to a mini-biography.

The final phase of the unit will have the largest amount of current, factual information about Mars. It will begin with a review of the vocabulary the students will encounter. A "splash" of words is posted. Students are instructed to select three of the words and attempt to put them in a meaningful context – a sentence, a picture, a phrase will do. These predictions are placed on post-it notes and attached to the word splash. Words the students will be asked to examine include: orbiter, lander, rover, Viking, Pathfinder, CO_2, sol, Sojourner, rover, crater, volcano, fault, ridge, canyon, basin, atmospheric pressure, erosion, gravity, mass, nitrogen, argon, opposition, retrograde, orbit. Student responses that correctly identify the context are pointed out. Words that have multiple meanings such as fault, basin, and mass are highlighted. Viking, Pathfinder, and Sojourner are noted as being capitalized, indicated they are titles of something.

After some explication of the vocabulary, students will begin to read and categorize a more robust data set. Information on the geology, atmosphere and climate, the incidence and importance of the presence of water, and summaries of the Mars missions will occupy the students' time for several class periods. Once the data set has been separated out, categorized, and discussed, students will identify an area of interest. This interest area will be the basis of a short research project.

LESSON PLANS

Lesson One: Johannes Kepler and the Elliptical Orbit

This lesson occurs near the beginning of the unit, after students have examined Mars as it would have been viewed by ancient people. Students will be reminded of the appearance of Mars in the sky, how it appears to move backward, stop, and then move forward again. As a hook, students will be shown a variety of optical illusions, particularly ones that show objects that have the same dimensions but due to their positioning, appear to be different sizes. Students will need to measure the objects and confirm that they are indeed the same length or width or circumference. They will be asked to consider what this means in terms of using our sight as a single source of data. A guiding question will be posed, "How did astronomers determine orbit and distance between the planets before space exploration was possible?"

Following this demonstration, students will be given a series of passages. The passages will provide a summary of the evolution of astronomical thought: from Ptolemy to Copernicus and finally to Kepler. The passages will primarily be narrative. The information will not be sequenced, however, and they will need to put it in order. Pairs of students will work on this task until the order is complete. Then students must explain why they chose the order they did. To close the activity, students will need to explain in their own words what the evolution was.

The final activity will involve manipulatives and modeling of the orbit of Mars compared to that of the sun and Earth. Sheets of paper with a pattern illustrating Mars' orbit and Earth's orbit will be given to the students. Students will move colored balls representing the two planets and trace their paths. Once Earth's shorter orbit will "overtake" the longer orbit of Mars and students will be able to see the optical illusion.

Lesson Two: "The Face" on Mars

Prior to this lesson, students would have learned of Shiaparelli's *canali* and Lowell's attempts at proving that intelligent life existed on Mars based on the idea that the "canals" were artificially made. They would have heard *War of the Worlds* and read about the public's panic in the aftermath. Students will be shown the image that Richard Hoagland contends is an artificially engineered "temple" created by a humanoid race on Mars. They will only be told that it is a true photograph of an object found on the surface of Mars. They will be asked to generate questions and make predictions about it. They will be asked, "Does this image prove anything about Mars?"

Next, quotes from Hoagland's website will be posted beneath the image. His arguments suggesting that NASA is withholding information will be considered. His website will be projected for the class to consider. Another question will be posed, "Do this man's statements seem reasonable?" Any and all student responses will be taken.

A new image of the object purported to be "The Face" will be shown to the students. They will be told that this is a newer photograph and that it was taken at closer range. Students will be asked to determine how it might have been possible that they had seen a "face" in the previous picture. Their previous experience with optical illusions should assist them with this question.

To conclude, Phil Plait's website *Bad Astronomy* will be projected along with his humorous refutation of Hoagland's argument. Students will read about each web author's credentials and consider who might be the more reliable source. To close the lesson, students will be simply asked, "and what did you learn today?"

Lesson Three: Mars Exploration Now

To reiterate, the unit is not meant to teach mastery of specific science objectives as would be found in physical science, however, it is meant to lay a foundation of knowledge and intellectual disposition that might aid their understanding in that content area. This lesson is a multiple day event, as it requires students to comb through quite a bit of information about the current status of Mars exploration. Three areas of knowledge will be covered: the presence of water on Mars connected to evidence that has lead scientists to believe life existed on Mars, the methods and technicalities of Mars exploration, and how Mars compares to Earth in terms of geology, atmosphere, climate, and other physical aspects. Facts connected to these areas will be listed and scrambled on a handout. Students will only be told that they will be learning about current knowledge about Mars. They will also be told that they should find many answers to their initial questions generated at the beginning of the unit.

Students will work with highlighters and the handout to classify each fact. Once they have classified every fact, they will cut the handout into separate strips of paper and sort the facts into categories. Once they have created their categories, they will write short conclusions about each, summarizing the knowledge. Student groups will be asked to share their categories and explain the reasoning behind it. Answers to questions placed on the KWL chart will be posted.

Students will now be prepared to engage in a deeper study of this material. They will be asked to select an area of the Mars unit in which they had particular interest. They will be given time and instruction in creating an expository report on their area of interest.

CONCLUSION

The "at-risk" student in today's high school classroom usually knows how to read if all reading is simply decoding the text. They are not practiced, however, in the habit of reading and comprehending a variety of texts. The more rigorous tasks of high school are often an exercise in failure due to their lack of experience with interdisciplinary language. They may read it, but they

don't "get" it. It is our responsibility to shepherd them through this language, modeling how we comprehend text, and providing them material that is accessible, rich and engaging. The "gift" to the English teacher is that they *are* able to provide language experiences from across the content areas.

Students also need to understand that learning often begins with questioning, and it is in pursuit of the answers to our questions that we learn. They need to become aware that an education is not about being able to pick the right answer from four options. We need to give them opportunities to practice the thinking skills required to make meaning. Hopefully, with in-depth studies as presented in this unit, they may have that opportunity.

APPENDIX

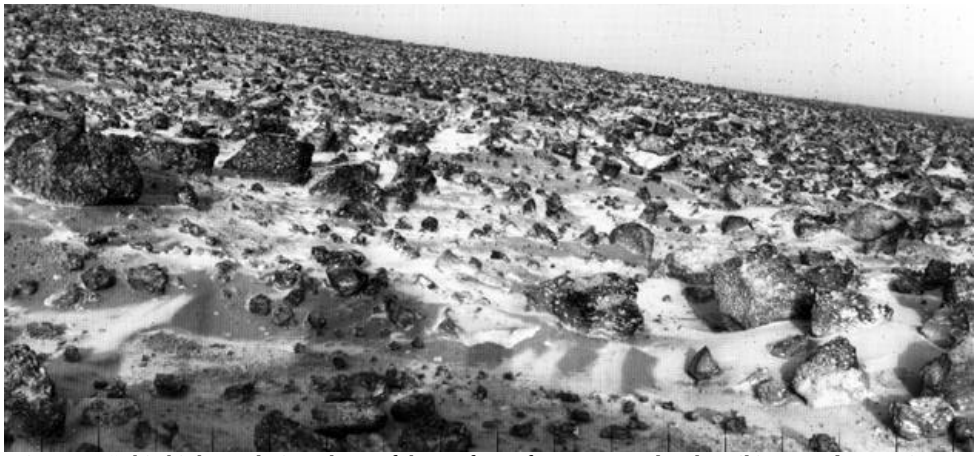

Figure 1, "This high resolution photo of the surface of Mars was taken by Viking Lander 2 at its Utopia Planitia landing site on May 18, 1979, and relayed to Earth by Orbiter 1 on June 7th. It shows a thin coating of water ice on the rocks and soil." Source: NASA http://nix.larc.nasa.gov/search;jsessionid=2kymqr5xhtl6q

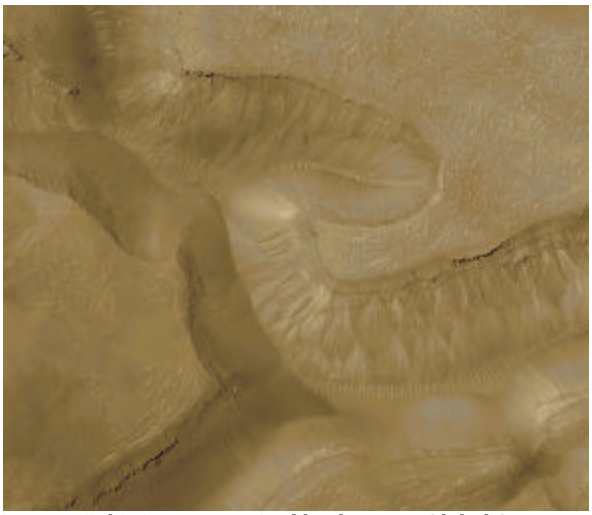

Figure 2, "This image, acquired by the Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) in May 2000 shows numerous examples of martian gullies that all start--or head--in a specific layer roughly a hundred meters beneath the surface of Mars." Source: NASA http://grin.hq.nasa.gov/BROWSE/mars_global_surveyor_1.html

Figure 3, Mars surface, Aug 3,1976. Source: NASA http://mars.jpl.nasa.gov/gallery/martianterrain/index.html

Figure 4, "The sharpest view of Mars ever taken from Earth was obtained by the recently refurbished NASA Hubble Space Telescope (HST). This stunning portrait was taken with the HST Wide Field Planetary Camera-2 (WFPC2) on March 10, 1997, just before Mars opposition, when the red planet made one of its closest passes to the Earth (about 60 million miles or 100 million km)." Source: NASA, http://photojournal.jpl.nasa.gov/catalog/PIA01249

ANNOTATED BIBLIOGRAPHY

Works Cited

Instructional Strategies

Beers, Kyleen. *When Kids Can't Read: What Teachers Can Do.* Portsmouth, NH: Heinemann, 2003.
An absolutely comprehensive text on how to approach the myriad obstacles struggling secondary students must overcome to become literate. Includes theoretical and practical knowledge to assist students in decoding, vocabulary, spelling, comprehension, and responding to literature.

Brozo, William. *To Be a Boy, To Be a Reader: Engaging Teen and Pre-teen Boys in Active Literacy.* Newark, DE: International Reading Association, 2002.
The book discusses instructional strategies and dispositions that might help engage young men in reading. The author focuses largely on exploring archetypes in literature that represent positive male role models, but also discusses research studies examining a group of students whose literacy needs appear to be neglected in the traditional high school curriculum.

Daniels, Harvey and Steven Zemelman. *Subjects Matter: Every Teacher's Guide to Content-Area Reading*. Portsmouth, NH: Heinemann, 2004.
Further discussion of the theory and practice of literacy in the content areas; highly informative and of practical use.

Jensen, Eric. *Teaching with the Brain in Mind.* Alexandria, VA: Association for Supervision and Curriculum Development, 1998.
Educator translates the latest understandings in neuroscience to practices in the classroom.

Joyce, Bruce and Marsha Weil. *Models of Teaching.* Needham Heights, MA: Allyn and Bacon, 1992.
Classic textbook articulating instructional methods grounded in theory and research.

Marzano, Robert J., et al. *Classroom Instruction that Works: Researched-Based Strategies for Increasing Student Achievement.* Alexandria, VA: Association for Supervision and Curriculum Development, 2001.
The authors report on a meta-analysis of hundreds of scientific, experimental studies of specific instructional strategies. They describe the strategies that garnered the strongest effect sizes in terms of student achievement.

Serafini, Frank and Cyndi Giorgis. *Reading Aloud and Beyond.* Porstmouth, NH: Heinemann, 2003.
The authors argue for the continuation of reading aloud to students as the get older. Provides methods for extending the learning possible from teacher read-alouds.

Tovani, Chris. *I Read It, but I Don't Get It: Comprehension Strategies for Adolescent Readers.* Portland, ME: Stenhouse Publishers, 2000.
Easy-to-follow, classroom-based examples of teaching comprehension to adolescents.

Vacca, Richard T. and Jo Anne L. Vacca. *Content Area Reading*. New York: HarperCollins, 1996.
Comprehensive text on methods for content area reading.

Project 2061 Benchmarks for Science Literacy. American Association for the Advancement of Science. February 13, 2005. http://www.project2061.org/tools/benchol/bolintro.htm
This website provides a "big picture" approach to science literacy and makes concrete statements, called benchmarks, that identify the skills and knowledge students will use as individuals.

Mars Resources

Bergreen, Laurence. *Voyage to Mars: NASA's Search for Life Beyond Earth.* New York: Riverhead Books, 2000.
Provides biographical information on the scientists and engineers who are currently pursuing Mars exploration.

Bone, Neil. *Mars Observer's Guide.* London: Firefly Books, Inc, 2003.
Handbook for amateur astronomers.

Great Images in NASA. National Aeronautics and Space Administration. March, 2005. <http://grin.hq.nasa.gov/>
A smaller database of images from NASA's historical projects.

Hoagland, Richard. *The Enterprise Mission.* March, 2005. <http://www.enterprisemission.com/>
Rather flamboyant website dedicated to the author's hypothesis and claims regarding space exploration and discoveries. Some of the material may well be accurate, but Mr. Plait (see below) does a good job of debunking several of Mr. Hoagland's theories.

Moore, Patrick. *Patrick Moore On Mars*. London: Cassell, 1998
Well-known expert on history of astronomy discusses Mars from the past through the current expeditions.

Morton, Oliver. *Mapping Mars: Science, Imagination, and the Birth of a World.* New York: Picador USA, 2002
Astro-geographer describes the journey to map Mars.

NASA's Mars Exploration Program's Science Theme. National Aeronautics and Space Administration. March, 2005. <http://mars.jpl.nasa.gov/science/index.html>

NASA's Mars Exploration Program, Image Gallery. National Aeronautics and Space Administration. March, 2005. <http://marsprogram.jpl.nasa.gov/gallery/images.html>
The home web address is the start of an extensive set of resources on the historical and current status of Mars exploration. This site in particular provides a large database of public domain images of Mars and other related subject matter.

NASA Image Exchange (NIX). National Aeronautics and Space Administration. March, 2005. <http://nix.larc.nasa.gov/home>
A more general database of images from the full spectrum of NASA projects. A search engine is provided for the user to find an image of the needed subject.

Plait, Philip. *Bad Astronomy.* March and April 2005. http://www.badastronomy.com
Humorous take on poorly reported astronomy in the news and in popular culture.

--- "Richard Hoagland's Nonsense." *Bad Astronomy*. March and April 2005. <http://www.badastronomy.com/bad/misc/hoagland/index.html>
This is the article that addresses Richard Hoagland in particular.

Planetary Photojournal: NASA's Image Access Home Page. National Aeronautics and Space Administration. March 27, 2005. <http://photojournal.jpl.nasa.gov>.
Yet another database, much more general, of images from NASA's work.

Sheehan, William and Stephen James O'Meara. *Mars: The Lure of the Red Planet.* Amherst, NY: Prometheus Books, 2001.
The inspiration for much of the unit: an extremely engaging discussion of Mars as an object of humankind's fascination.