

The Search for Humanity— Connecting Physics and the Arts in an American Humanities Class

Debi Kierst

Academic Setting and Rationale for Unit

Sandia High School is a four-year comprehensive public school that serves approximately 2000 students. The school is situated in the middle of an established neighborhood which is approximately 65% Anglo, 21% Hispanic, and 14% African-American, Asian-American, Native-American and "other." The majority of the parents of our students are employed in professional, technical, and executive occupations. Approximately 63% of the senior class of 2000 reportedly went on to college.

The unit is designed for use in an 11th grade American Humanities college preparatory curriculum where social studies, literature, and the arts are combined to give students an alternative to the traditional approach to required courses in American History and American Literature. The course is team-taught and takes a chronological look at the development of America as a nation. We explore the major eras of America's historical development looking at the *zeitgeist* of each period as it is reflected in social issues, political movements, and artistic endeavor. My intention, with this unit and others like it for various periods of our history, is to include the contributions of important scientists in our work to help the students see how scientific discovery influenced the thinking of the time. Hopefully, this inclusion will deepen and enrich the interdisciplinary study of America's development for our students.

Intellectual Background

As most current educational research shows, multidisciplinary education is highly beneficial to the intellectual development of the typical high school student. Whether a student's interest lies in history, language arts, science, mathematics, fine arts or in some other area, allowing students to see the interconnectedness in all that they are learning supports the feeling that their education is relevant. For a number of years, various forms of humanities based curricula have enjoyed an enormous amount of success. The traditional combinations of the academic areas of social studies and English (or language arts), with the creative areas of music, visual art, drama, creative writing and dance have produced many fine programs across the United

States. A much more difficult, but perhaps more interesting and beneficial combination might be the inclusion of the sciences, specifically physics, into this mix. Suppose a student could see the connection between a work of art or a social movement and a scientific discovery or theory? Suppose that as a student is learning about the Enlightenment in Europe and the American Colonies through the history, literature and perspectivist art of the period, he or she is also learning about Newton's *Principia* and how his ideas affected the thinking of generations to come. Suppose that as students are learning the mathematics required for a good background in physics, they are also learning a more conceptual way of thinking about nature, humanity and the world around them through the connection of science to art, music or literature. What a much more enriching experience that would be!

The purpose of this curriculum unit is to begin to make that connection between the humanities and science. By looking at a particular scientific discovery or concept, in this case Einstein's special theory of relativity, the student will begin to see the connection between these discoveries and American culture since that time—and, perhaps most importantly, the connection between seemingly unrelated facets of education. How have our attitudes and philosophies about life changed since 1905 when Einstein published his famous paper on the special theory of relativity? What other discoveries were enhanced, or perhaps even made possible by his theories? How do we see these attitudes and philosophies manifested in our careers, in our art, in our daily lives?

New ideas, new discoveries in any area, whether it is science, literature, philosophy or art can cause sweeping changes in the way we think about things. Because of the philosophers of the Golden Age of Greece who discovered ways to organize knowledge, civilization turned away from defining reality by the magic and mysticism of their religion and turned to reason and logic as a way to explain every day existence. In the late medieval period, the invention of the printing press fed the hungry minds of the common man, and, as a result, the world experienced exponential human development in a time called the Renaissance in Europe. Perspectivist art was developed, modern science was born, and Humanism defined the spirit of the age. In the late 17th century, Sir Isaac Newton, the father of classical physics, published *Principia Mathematica* and *Optiks*, which for over 200 years defined the way Western civilization looked upon time, space and light. He presented a method for studying and describing the world in pure mathematics, where everything has a place and causality is the order of the day. In 1905, Albert Einstein published a

paper, the focus of which became known as "the special theory of relativity". This theory exploded Newton's ideas of absolute time, space or motion, and theorized that the speed of light is the only constant – space and time are both relative. Suddenly, even common sense didn't make sense anymore.

Defining Humanities and Science

What do we mean when we say that we study the humanities? Or that we offer a course in the "Humanities?" Webster's New Universal dictionary defines humanities this way:

the humanities 1. language and

literature, especially the
especially the
classical Greek
and Latin 2. the
branches of
learning concerned
with human
thought and
relations, as
distinguished from
the sciences;
especially
literature and
philosophy, and
often the fine arts,
history, etc....

The Humanities course is often some combination of the "humanistic" disciplines: history, literature, art, theatre, music, dance, philosophy. When we study the humanities we seek to define and understand what it means to be human. We strive to understand our values, and we explore our attitudes, behavior patterns and ideas that affirm our participation in mankind. Earl Shorris, founder of an education program for the poor in New York, The Clemente Course in the Humanities, maintains that "the study of the humanities can reconnect the poor to the ideas of democracy and civic involvement...the humanities have great appeal to give people a sense of self, to see the world and themselves differently in the Greek sense of reflective thinking, for autonomy. People who know the humanities become good citizens, become active, not acted upon." (Riechers 2). A course in the humanities seeks to be holistic. It explores the human

condition—an exploration that is relatively subjective and generally filled with emotion, myth and spiritual concerns.

Science on the other hand is defined in Webster's as:

- science, 1. a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws
2. systematic knowledge of the physical or material world

Paul Hewitt, in his book *Conceptual Physics*, says that, "Physics is the *basic* science. It's about the nature of basic things such as motion, forces energy, matter, heat, sound, light, and the insides of atoms. An understanding of science begins with an understanding of physics". A physics course requires one to be objective and concerned with what Leonard Shlain, in his book *Art and Physics*, calls "external reality." The language of physics is generally the language of mathematics. Physics is logical, systematic, orderly and disciplined. As Lord Kelvin stated in the 19th century, "I often say that when you can measure something and express it in numbers, you know something about it. When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind." (Hewitt 3). In definition, the two disciplines appear to be worlds apart.

But how different are the natures of science and humanities, really? Alan Lightman in his book *Great Ideas in Physics* says, "Discoveries in science are not just about nature. They are about people as well...Science is a human activity as well as an exploration of nature, and, as a human activity, science connects to philosophy, history, literature, and art." Both science and the humanities are ways of looking at the world and discovering our place in it. "The principal values of science and the arts are comparable. In art we find what is possible in human experience...A knowledge of science similarly tells us what is possible in nature. Knowledge of both the arts and the sciences makes for a wholeness in the way we view the world and the decisions we make about it and ourselves. A truly educated person is knowledgeable in both the arts and the sciences." (Hewitt 12).

Physics

Newton's Classical Physics

"We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances," said Sir Isaac Newton. Newton, an English physicist, mathematician and

philosopher, is considered to be one of the most important scientists of all time. Newton's brilliance and his ability to build upon ideas and past discoveries of other brilliant minds helped him to create a set of laws that used mathematical theory to explain such phenomena as motion, gravity, and the behavior of light. He used mathematical theories to predict the behavior of these phenomena, and then compared predictions to observation in experiments. He then used his results to check his theories. In essence he converted physics from a science of explanation to a mathematical system with rules and laws. And he invented calculus, a math with which he could accomplish all of this.

In 1687 Newton published *Principia Mathematica Philosophiae Naturalis*, the "Bible" of classical physics and generally thought to be the greatest scientific book ever written. "Newton showed that the universe ran according to natural laws that were neither capricious nor malevolent—a knowledge that provided hope and inspiration to scientists, writers, artists, philosophers, and people of all walks of life and that ushered in the Age of Reason. The ideas and insights of Isaac Newton truly changed the world and elevated the human condition." (Hewitt 58). Newton's work was indeed so significant to the scientific community that it was more than two centuries before scientists felt a need for any kind of revision. The revisions that did finally occur led to the modern theory of relativity that deals with the extraordinarily high speed of light, and the quantum theory that deals with extraordinarily small dimensions. The principles that Newton formulated are still valid when dealing with more ordinary circumstances.

Among the principles that Newton formulated were his ideas about time, space and light. He described a reality in which "Absolute, true and mathematical time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called duration..." And, "Absolute space, in its own nature, without regard to any thing external, remains always similar and immovable." (Newton 17). In other words, Newton describes time and space as the constants in the universe, and light as what moves through both. He believed, as did Galileo and even Aristotle before him, that there exists a reference point of absolute rest against which all other motions could be measured. However, he also says,

"It may be that there is no body really at rest, to which the places and motions of others may be referred. But we may distinguish rest and motion, absolute and relative, one from the other, by their

properties, causes and effects. It is a property of rest that bodies really at rest do rest in respect to one another. And therefore it is possible that in the remote regions of the fixed stars, or perhaps far beyond them, there may be some body absolutely at rest." (Newton 19).

In spite of the fact that Newton himself believed that there were problems with his idea of absolute rest, he was able to reconcile his concerns with the idea that absolute and relative rest and motion could be distinguished from one another.

Einstein and Relativity

A man said to the universe,
"Sir, I, exist."
"However," replied the universe,
"The fact has not created in me
A sense of obligation."

--Stephen Crane
(Daniel 408)

Albert Einstein was born in Germany in 1879. As the story goes, he was slow as a child, to the point that his parents feared he might be mentally retarded. He began his formal education in 1886, excelled in mathematics and at playing the violin, but never did particularly well on his examinations. Einstein did attend a secondary school in Aarau, and then in 1896, he went to the Swiss Federal Institute of Technology in Zurich. He graduated from there in 1900, and because he could not get accepted for graduate work anywhere, he taught mathematics and physics in a secondary school for a short time.

After various temporary jobs, with the help of a friend's father, Einstein obtained a job in 1902 as a "technical expert third class" in the patent office in Bern, Switzerland. The post was temporary at first, but in 1904 the position was made permanent. He continued his study and work in theoretical physics but in his spare time, and without the benefit of an academic setting.

In 1905 Albert Einstein published four major papers. The first was an examination of electromagnetic radiation of light using Max Planck's quantum hypothesis. It was for this that he won the Nobel Prize in 1921. The second proposed what is today called the special theory of relativity. Einstein based his new theory on the ideas that the laws of physics had to have the same form in any frame of reference, and that

the speed of light remained constant in all frames of reference. The third of his papers concerned statistical mechanics. The paper provided convincing evidence for the existence of atom-sized molecules. Finally, later in 1905, he elaborated on his theory of special relativity discussing how mass and energy were equivalent. In this paper he introduced the famous equation $E=mc^2$. Additionally, in 1905, Einstein submitted a thesis to the University of Zurich called *On a New Determination of Molecular Dimensions* which earned him a doctorate.

In addition to his remarkable work in the field of physics, Albert Einstein was also greatly concerned with the state of mankind. He was an intense advocate of world peace. The time during which he lived was rife with great violence and cruelty, and perhaps he saw that the scientific discoveries that he and many others had made in the arena of nuclear power needed to be controlled. It was too dangerous to allow those who advocated violence and cruelty to have access to nuclear weapons. Of Einstein, C.P. Snow said, "Einstein was the most powerful mind of the twentieth century, and one of the most powerful that ever lived. He was more than that. He was a man of enormous weight of personality, and perhaps most of all, of normal stature...I have met a number of people whom the world calls great; of these, he was by far, by and order of magnitude, the most impressive. He was—despite the warmth, the humanity, the touch of the comedian—the most different from other men." (Hewitt 663).

The Theory of Special Relativity

According to Newtonian physics, space and time were rigid and constant. Light was to be measured by one who was at rest in the *ether*. Einstein changed all that. In his theory of special relativity, he changed the way we understand space and time. In his world, the only constant is the speed of light—substances are moving relative to each other. Space and time are bound to each other using two postulates:

1. If a system of co-ordinates K is chosen so that, in relation to it, physical laws hold good in their simplest form, the *same* laws also hold good in relation to any other system of co-ordinates K' moving in uniform translation relatively to K. This postulate we call the "special principle of relativity." The word 'special' is meant to intimate that the principle is restricted to the case when K' has a motion of uniform translation relatively to K, but that the equivalence of K' and K does not extend to the case of non-uniform motion of K' relatively to K."
2. Thus the special theory of relativity does not depart from

classical mechanics through the postulate of relativity, but through the postulate of the constancy of the velocity of light *in vacuo*, from which in combination with the special principle of relativity, there follow, in the well-known way, the relativity of simultaneity, the Lorentzian transformation, and the related laws for the behaviour of moving bodies and clocks (Einstein, p. 111).

Einstein's theory and its consequences violate what our common sense knows to be true. The theory deals with ideas and concepts so far removed from our "reality"—traveling at close to the speed of light, the concept of fourth dimension, compressed or expanded time, no stationary uniform point of reference—that we have trouble ascertaining his meanings. A simpler statement of the postulates, and a look at them individually might aid in understanding.

Postulate #1 "The laws of physics must be the same for all observers moving in non-accelerated (inertial) reference systems." (Vargish 65). "On a jet airplane going 700 kilometers per hour, coffee pours as it does when the plane is at rest; we swing a pendulum and it swings as it would if the plane were at rest on the runway. There is no physical experiment we can perform, even with light, to determine our state of uniform motion. The laws of physics within the uniformly moving cabin are the same as those in a stationary laboratory." (Hewitt 637). The idea here seems very clear. Objects within a specific frame of reference that are in uniform motion behave in the same way as they would in a frame of reference that is at rest. Consequentially, if we are, say, passengers on a moving train looking out the window of our car and we happen to see another moving train pass by, we are only aware of the relative movement between the two. We cannot tell which train is moving or, if, indeed, one is entirely at rest. All motion is relative to other frames of reference; there is no preferred frame of reference.

*Postulate #2: "The speed of light in a vacuum is the same, regardless of the speed of the light source with respect to the observer of the light" (Vargish 70). Einstein's postulate seems very clear, very concise. There are some interesting consequences of his statement, however. The concept of *simultaneity*, that is the occurrence of two or more events at the same moment (the basis of our whole understanding of time) is suddenly affected. In his original paper, Einstein stated, "We have to take into account that all our judgments in which time plays a part are always judgments of *simultaneous events*. I mean something like this: If, for instance, I say, 'The pointing of the small hand of my watch to 7 and the arrival of the train*

are simultaneous events' ". However, two events that are simultaneous in one frame of reference won't be simultaneous in a frame of reference moving relative to the first frame. An example from Hewitt's *Conceptual Physics* helps to illustrate this point.

Consider, for example, a light source in the exact center of the compartment of a rocketship. When the light source is switched on, light spreads out in all directions at speed c . Because the light source is equidistant from the front and back ends of the compartment, an observer inside the compartment finds that light reaches the front end at the same instant it reaches the back end. This occurs whether the ship is at rest or moving at constant velocity. The events of hitting the back end and hitting the front end occur simultaneously.

But time in one frame of reference may be different from time in another frame. To an outside observer who views the same two events in another frame of reference, say from a planet not moving with the ship, these same two events are not simultaneous. As light travels out from the source, this observer sees the ship move forward, so the back of the compartment moves toward the beam while the front moves away from it. The beam going to the back of the compartment, therefore, has a shorter distance to travel than the beam going forward. Since the speed of light is the same in both directions, this observer sees the event of light hitting the back of the compartment before seeing the event of light hitting the front of the compartment (Hewitt 638).

It is common sense for us to think that events that appear simultaneous to one person appear simultaneous to another person. Einstein's postulates tell us that this common sense idea is just not true in all cases. Of course, the speed at which things must be moving to discern this difference must be extremely high, but the postulate #2 states that simultaneity is simply not absolute.

Another consequence of Einstein's second postulate is the idea of *time dilation*. According to Einstein, time is not absolute, but relative depending on the motion of the observer relative to what is being observed. For an example of this idea, again I will turn to Hewitt as he describes the "Twin Paradox." In this example he also uses the Doppler shift in light (the frequency of light emitted by an approaching source increases, while the frequency of light from a receding source decreases).

"A dramatic illustration of time dilation is provided by identical twins, one an astronaut who takes a high-speed round-trip journey in the galaxy while the other stays home on earth. When the traveling twin returns, he is younger than the stay-at-home twin. How much younger depends on the relative speeds involved. If the traveling twin maintains a speed of 50% the speed of light for 1 year (according to clocks aboard the spaceship), 1.15 years will have elapsed on earth. If the traveling twin maintains a speed of 87% the speed of light for a year, then 2 years will have elapsed on earth. At 99.5% the speed of light, 10 earth years would pass in one spaceship year. At this speed the traveling twin would age a single year while the stay-at-home twin ages 10 years.

Why is this so? Why is the opposite not true? Think about a spaceship hovering completely at rest relative to a planet. Suppose the spaceship sends regularly spaced flashes of light to the planet. The light flashes will arrive at the planet at a speed of c . Since there is no relative motion between the two, the light flashes will be received as frequently as they are sent. However, when motion is involved, the situation is quite different. When the ship travels toward the planet, the flashes are seen more frequently, and when the ship travels away from the planet, the flashes are seen less frequently. This happens because the light flashes have more distance to travel when the ship is moving away, and less

distance to travel when the ship is approaching.

In applying this idea to the twin story, we see the following: Suppose the traveling twin recedes from the earthbound twin at the same high speed for 1 hour and then quickly turns around and returns in 1 hour. Suppose the speed at which the ship is traveling is fast enough that the light flashes seen by the planet appear to take twice as long to occur as they are actually being emitted from the ship as it travels away from the planet. And suppose the effect of returning is just the opposite. The flashes will appear to take half the time. The traveling twin takes a round trip of 2 hours, according to all clocks aboard the spaceship. This trip will not be seen to take 2 hours from the earth frame of reference, however.

As the ship recedes from the earth, it emits a flash of light every 6 minutes. These flashes are received on earth every 12 minutes. During the hour of going away from the earth, a total of ten flashes are emitted. If the ship departs from the earth at noon, clocks aboard the ship read 1 pm when the tenth flash is emitted. On earth, the clock will read 2 pm. The time it takes the earth to receive 10 flashes at 12-minute intervals is 120 minutes at 12 minutes per flash.

During the hour of return the ship will emit ten more flashes at 6-minute intervals. These flashes are received every 3 minutes on earth; so all ten flashes come in 30 minutes. A clock on earth will read 2:30 pm when the spaceship completes its 2-hour trip.

Earth frame of reference:

10 flashes @ 12 min = 120 minutes

10 flashes @ 3 min = 30 minutes

total = 150 minutes or 2.5 hours

Spaceship frame of reference:

20 flashes @ 6 min = 120 minutes or 2 hours

Now consider the same trip again, only this time with flashes emitted from the earth at regularly spaced 6-minute intervals in earth time. From the frame of reference of the receding spaceship, these flashes are received at 12-minute intervals. This means that five flashes are seen by the spaceship during the hour of receding from earth. During the spaceship's hour of approaching, the light flashes are seen at 3-minute intervals, so 20 flashes will be seen.

So, we see that the spaceship receives a total of twenty-five flashes during its 2-hour trip. According to clocks on the earth, however, the time it took to emit the twenty-five flashes at 6-minute intervals was $25 \times (6 \text{ minutes})$ or 150 minutes. (Hewitt, pp. 645-650).

Thus, the paradox. Each twin measures the other as having aged more slowly than himself.

Finally, when looking at the theory of special relativity, one has to come to terms with the fact that Einstein forces us to look at the universe as more than three-dimensional. We must accept *space-time* as a kind of fourth dimension of reality. This is quite difficult though because, as Isaac Asimov says in his introduction to the novel *Flatland*, "If a limitation is inherent, because of a body's physical limitations, how can one get round it? How does one explain color to someone who has been blind from birth, or music to someone who has been deaf from birth? One can explain the differing wavelengths of light and of sound; one can refer to analogous differences in sensations that can be experienced, such as those of touch. An intellectual understanding can be reached, perhaps." (Abbott x). The fourth dimension perhaps is timeless and spaceless except as it is perceived from any one particular frame of reference. "The distinction, therefore, between space and time is subjective—that is to say, the observer, although unconsciously, is affected by his circumstances in his discrimination between the two. We cannot therefore suppose that this distinction corresponds to an objective physical reality. And so we are forced to the conclusion that we live in a four-dimensional world..." (Durrell 85).

Certainly Einstein's special theory of relativity led the world into uncharted territory. He forced us to look at things in entirely new ways and helped us to see that imagination and creativity are important facets of human development. "What I'm really interested in," he says, "is whether God could have made the world in a different way; that is, whether the necessity of logical simplicity leaves any freedom at all." (Taylor iii). What Einstein also did, through his discoveries, was to influence and encourage others to reach farther than they had reached before. His theories played a role in advances in physics and other sciences that have led us into the nuclear age and into the age of technology. We are exploring far beyond whatever might have been possible if it had not been for his discoveries.

Humanities

Modern Art

If Albert Einstein was intellectually exploring space, time and light, modern artists were, at the same time culturally exploring the same ideas. About the time that Einstein was formulating his theories regarding special relativity, the art world was giving birth to a whole new way of representing reality. Leonard Shlain, in his book *Art and Physics*, lists three painters who ushered in the era of modern art. Impressionist Edouard Manet questioned and experimented with perceptions of space and totally violated the laws of perspectivist painting. In his work *le Dejeuner sur l'herbe* Manet destroys single point perspective by joining foreground and background, and in his *Music in the Tuileries* and *Boats*, he wreaks havoc on the linear horizon line by curving it. Additionally, in *Music*, he distorts the generally accepted view of "vertical" by curving the trunks of his trees. Another impressionist, Claude Monet, began to explore the essence of time in his work, refusing to believe that an object could be fully realized in only one frozen moment, as had been the focus of realistic, perspectivist painting. He did a series of paintings showing the entrance of the Cathedral at Rouen at different times and in different lights. And, finally, post-impressionist, Paul Cezanne, whom some consider to be the father of modern art, spent his career discovering the relationship between space, light and matter. Cezanne introduced the idea that a painting could have multiple perspectives or points of view. In his *Still Life with Fruit Basket* Cezanne avoids using a linear perspective by deliberately "breaking" the line of the table, and he varies the perspective in the painting by creating different perspective points for several objects in the composition. Each of these artists presented a way of thinking that was contrary to what was traditional in their world, and interestingly, what they were

exploring was what the scientific community was also focusing on at the time: space, time, light and matter.

Following closely on the heels of Impressionist and Post-Impressionist art was a movement known as Cubism. "Cubist space violates all concepts of two or three-dimensional perspective." (Sporre 374). The genius of artists Pablo Picasso and Georges Braque brought the art world to new heights with their explorations of space and multiple frames of reference. "In importance, Cubism has rightly been compared to the revolutionary discovery of perspective in the Renaissance." (Shlain 189). The cubists made no attempt at external reality in their paintings. All visual segments or sides of an object can be seen at once. For example, Picasso's *Les Femmes d'Alger*, painted in 1907, depicts angular, simplified forms showing many sides of the same human figure, as though we were looking at them from all sides at once. "Explicit in Einstein's formulas and implicit in a Cubist painting is the concept that all frames of reference are relative to one another... Additionally, the cubists chose to limit the color palette so that they might better focus on the exploration of space. Cubist artists broke new ground by choosing to paint, as Picasso said, what they thought as opposed to what they saw." (Shlain 192,187).

Another modern artistic style that could be seen to reflect or reinforce the concepts of Einstein's theories is that of surrealism, particularly in the paintings of Salvador Dali. Allied strongly, too, with the discoveries of Sigmund Freud and his exploration of the subconscious, the surrealists began to experiment further with concepts and ideas centering on time, light and space. In a description of *The Persistence of Memory* Sporre, says, "The whole idea of time is destroyed in these wet watches (as they were called by those who first saw this work) hanging limply and crawling with ants...the irrationality of all can be entrancing. The starkness and graphic clarity speak of the unpolluted light of another planet, yet nonetheless reflect a world we seem to know." (Sporre, 379). Many of the symbols that Dali used also reinforced and reflected the thinking of Einstein. In *Hypercube* or *Crucifixion* Dali uses a "hypercube," or a four-dimensional representation of a cube, as the cross on which his Christ is hung.

Quite clearly, during the period centering around the turn of the century, that period known as "modern," artists and scientists alike were concerned with various relationships between time, light, space and matter. That there was any direct influence of scientist upon artist, or vice-versa, is doubtful, but there is obviously a connection as to what was occupying the great minds of the time.

Modern Literature

In many ways the modernist era in literature paralleled the development of the various anti-traditionalist movements in art as well as the development of Einstein's theory of Special Relativity. Both art and literature emphasized the role of the unconscious mind and the importance of the irrational. Internal experience was emphasized over outward reality. Chronology and causality were replaced by a more subjective, individual ordering of events. Modernist literature emphasizes a fragmented world with little or no connective "tissue." Just as Einstein's theory and modern art emphasized a break from a logical, ordered, causal universe—toward a universe full of multiple viewpoints and a counter-intuitive approach to the concepts of time and space—so did modernism in literature break from the traditional, realistic view of how a story should be told.

Nineteenth century fiction was characterized by its realistic approach. "A primary practical assumption that held for both painting and fiction was that the business of art is to mirror reality, especially to reflect the unity and integrity of the world. For this reason the image of the novel as a mirror—a device for reflecting natural, social, and psychological circumstance—is probably its dominant descriptive metaphor throughout the nineteenth century." (Vargish 38). Realistic fiction contained a reliable, trustworthy narrator who could guide us through a chronological series of events and lead us to a sensible conclusion—a single perspective or frame of reference, if you will. Modernist writers, on the other hand, chose to take us down a different path. They deliberately broke with past conventions and "the narrative voice becomes withdrawn, noncommittal." (Vargish 48). In fact, in many cases, a single narrator disappeared entirely. We are presented with multiple points of view, multiple perspectives, and multiple frames of reference.

Faulkner and The Sound and the Fury

Nobel Prize winning author William Faulkner was born in 1897 in Oxford, Mississippi. He is one of America's foremost representatives of the age of modernism in literature. For many years he was dismissed as an eccentric. His style was untraditional and innovative for his time—jumbled time sequences, stream-of-consciousness narration, and multiple perspectives—these are some of the major characteristics of the modernist writer. His novel *The Sound and the Fury* earned him critical acclaim, and from that point forward he began to receive serious notice as an important author.

The Sound and the Fury tells the story of the Compson family through the perspectives of four different narrators—the brothers Benjy,

Quentin, Jason, and, finally, through an omniscient narrator, Faulkner himself. Regarding the use of multiple narrators, Faulkner said:

I tried first to tell it with one brother, and that wasn't enough. That was section One. I tried with another brother, and that wasn't enough. That was Section Two. I tried the third brother, because Caddy was still to me too beautiful and too moving to reduce her to telling what was going on, that it would be more passionate to see her through somebody else's eyes, I thought. And that failed and I tried myself—the fourth section—to tell what happened, and I still failed (Minter 235).

Obviously, Faulkner felt a need for a multiple perspective to give the story its most complete telling, in spite of the fact that he still felt he hadn't quite achieved his purpose.

The title of *The Sound and the Fury* comes from Shakespeare's *Macbeth*:

Tomorrow,
and
tomorrow,
and
tomorrow
Creeps in
this petty
pace from
day to day,
To the last
syllable of
recorded
time,
And all our
yesterdays
have lighted
fools
The way to
dusty death.
Out, out,
brief candle!
Life's but a
walking

shadow, a
poor player
That struts
and frets his
hour upon
the stage
And then is
heard no
more. It is a
tale
Told by an
idiot, full of
sound and
fury,
Signifying
nothing.
--William
Shakespeare
Macbeth V.iv

As is obvious in the quote from the play, time has lost significance.
What is the meaning of time?

Vargish tells us: "Macbeth's image of the world as a stage and of language (expressive time) as mere noise, is echoed without compromise in Faulkner's novel: 'Then Ben wailed again, hopeless and prolonged. It was nothing. Just sound. It might have been all time and injustice and sorrow become vocal for an instant by a conjunction of planets.' The mentally arrested Benjy is the literally realized idiot of Macbeth's metaphor for life as a tale told by an idiot, and it is Benjy who tells the first tale of *The Sound and the Fury*" (Vargish 101).

The measurement of time becomes relative with each new narrator, and from the "stream-of-consciousness" approach that Faulkner uses in the telling, the significance of that measurement seems lost. Sarte said, "For Faulkner, time must be forgotten" (Minter 268).

Modern Music and Dance

Music and dance, as well as art, physics and literature, began making some major changes at the beginning of the 20th century in America,

as well as in the rest of the world. Many artists in both fields remained traditional in their approaches, but some broke new ground and made innovations that brought their respective art forms to new heights. In music, through the work of Bela Bartok, Arnold Schoenberg, Igor Stravinsky, Charles Ives, and Aaron Copland, rhythms, harmonies, sense of key and traditional tonality began to change. In dance, new traditions began with the work of Isadora Duncan, Martha Graham and Merce Cunningham.

Until the 20th century, music had followed much the same path as art and science. There was a "preferred reference frame"—the "home key"—which unified a piece of music. Musicians such as Schoenberg in his 1909 *Opus 11, No. 1*, began to experiment with atonality—music in which there is no home key. The preferred reference frame dissolved and each key became just as important as any other. Traditional tempos and rhythms also underwent change in the early 20th century. Igor Stravinsky varied tempos and rhythms with such abruptness that his *Le Sacre du Printemps* in 1913 caused a riot during a performance. He had challenged what audiences knew to be absolute in musical time, and they reacted violently to that change. Charles Ives, an American, created music which, at the time it was written, was considered to be unplayable: "He experimented with quarter tones, polytonality, and polyrhythms. His rhythms are often irregular and without measure delineation" (Sporre, p.392). Finally, Aaron Copland, another American, experimented with polytonality and manipulation of rhythms. In experimenting with the ideas of multiple reference frames (atonality or polytonality) and manipulation of time (dissonance and polyrhythms), 20th century music was going through some of the same explorations as science, art, and literature.

Though perhaps not dealing with the same thought processes as in the other disciplines, dance was going through remarkable change at the beginning of the 20th century. Beginning with Isadora Duncan, the "modern dance" movement took its first infant steps. Duncan was highly unconventional in her approach—dancing barefoot, in Greek-like costumes and she was deeply emotional in her approach. This approach was very controversial in her day. Martha Graham, another American, was probably the most influential figure in modern dance to this day. She maintained that, "Artistic individualism is fundamental. There are no general rules. Each work of art creates its own code" (Sporre 393). Again, the idea of no preferred frame of reference enters the artistic realm. Grahams' work, like Duncan's, was highly emotional, deeply psychological, and at times full of social criticism. She created a ballet around the music of Copland's *Appalachian Spring*. Merce Cunningham's works are marked by their

abstract nature and the idea that the same piece can be viewed from varying perspectives. He also emphasizes the importance of space, spreading it across the stage, allowing audience members to choose where to focus. "...he tends to allow each element of the dance to go its own way (Sporre, p. 393). Again, we can see that yet another discipline was exploring time and space in similar ways to others working at the beginning of the 20th century.

Implementation

Through the teaching of this unit, students in the 11th grade American Humanities class will better understand the *zeitgeist* of early 20th century America. The unit will last approximately four weeks and will include a weeklong introduction to historic events, scientific thought and artistic expression of the early 1900's, as well as a three week reading and analysis of William Faulkner's novel *The Sound and the Fury*. During this reading/analysis, connections will continually be made between ideas and concepts presented during the first week of the unit and stylistic elements and content of the novel.

The objectives listed here are the Content Standards and Benchmarks for Albuquerque Public Schools and the State of New Mexico that will be addressed in this unit. For conciseness, I have listed only the Standard followed by its Benchmark. Much more specific performance standards can be found online at: <http://www.aps.edu/aps/standards/index.html>.

- Strand I: Reading Process.

- Content Standard: The student employs appropriate reading strategies to read and interpret increasingly complex texts for a variety of purposes.

- Benchmark: The student develops and demonstrates proficiency with a variety of reading processes to analyze, interpret, and evaluate a wide variety of texts across content areas.

- Strand II: Reading Analysis.

- Content Standard: The student responds to, examines, and critiques historically and

culturally significant issues and events portrayed in literature that both illustrate and affect people, society, and individuals.

Benchmark: The student critiques and evaluates the literary and social merit of a variety of historically and culturally significant works.

○ Strand III: Expressive Language: Writing.

Content Standard: The student writes effectively for different audiences and purposes using appropriate writing strategies and conventions.

Benchmark: The student develops and demonstrates fluency and style in writing and a command of writing conventions across content areas to describe, narrate, express, explain, persuade, and analyze for a variety of purposes and audiences.

○ Strand IV: Expressive Language: Speaking.

Content Standard: The student speaks effectively for different audiences and purposes using appropriate speaking strategies and conventions.

Benchmark: The student develops and demonstrates fluency and style in speaking and a command of speaking conventions to describe, narrate, express, explain, persuade, and analyze for a variety of purposes and audiences.

○ Strand V: Receptive Language: Listening and Viewing.

Content Standard: The student demonstrates, analyzes, evaluates, and reflects upon the skills and processes used to communicate by listening to and viewing a variety of auditory and visual works.

Benchmark: The student critically evaluates the effectiveness of a variety of auditory and visual works, including multimedia presentations.

Materials Required:

- Video of Carl Sagan's *Cosmos* series (segment #8 on Relativity) or video of *The Mechanical Universe: Quad VII, "The Special Theory of Relativity"*
- Transparencies or prints of art work from the following periods (examples of works by particular artists are included):
 - Impressionism -- Manet's *Dejeuner sur l'herbe*, Monet's *Rouen Cathedral*, Renoir's *Moulin de la Galette*
 - Post Impressionism-- Seurat's *Sunday Afternoon in the Island of La Grande Jatte*, Cezanne's *Still Life with Fruit Basket*, Gauguin's *The Vision After the Sermon*, Van Gogh's *The Starry Night*
 - Cubism-- Picasso's *Les Femmes d'Alger (O. J. R. M.)*
 - Futurism-- Duchamp's *Nude Descending a Staircase*
 - Surrealism-- Dali's *Crucifixion and Persistence of Memory*, de Chirico's *The Nostalgia of the Infinite*, Magritte's *Time Transfixed*
- Musical recordings of:
 - Debussy-- *Prelude a l'apres-midi d'un*

faune

- Stravinsky-- *The Rite of Spring, The Firebird*
- Shostakovitch
- Ives-- *Unanswered Question*
- Copland-- *Appalachian Spring*
- Video examples of the dance of
 - Isadora Duncan--various
 - Martha Graham—ballet of *Appalachian Spring*
 - Merce Cunningham—*Summerspace, Winterbranch*
- Copies of *The Sound and the Fury*

(The teacher may substitute another novel, a short story, or poetry from the period to express the same stylistic elements of stream-of-consciousness, multiple perspectives, non-causality, etc.)

Sample Lessons and Activities

Week One—Moving Away from Traditional Reality *Days One and Two*

Days one and two will present an introduction to the *zeitgeist* of early 20th century thought, not just in America, but across the world. During the class, the students will be presented with four pairs of examples of expression of thought representing four different disciplines from two different periods. The periods chosen here are Neoclassicism and Modernism, primarily because of the comparison between Newtonian Physics and Einstein's Relativity.

- Science: Newton's definitions of absolute time and space, and his laws of motion; and Einstein's two postulates defining the theory of special relativity.
- Literature: a brief excerpt from Jefferson's *Declaration of*

Independence (which by this point the students have read and studied) and an excerpt from Franz Kafka's *The Confusion*.

- Music: a selection from a Mozart sonata, and a selection from Stravinsky's *Firebird*
- Art: a painting by Jacques-Louis David, and cubist work by Picasso or Braque

The students will be given time to observe (read, study, view, or hear) each pair of examples. While observing, each student will write his own individual response to each one of the pairs. He or she will describe the style and/or content of each example given. Then students will form groups of three and the groups will make a list of words or phrases that describe each period. When the group work is finished, the class will list the descriptors on the board and then will discuss the differences between the periods. The discussion should lead to an understanding of how 20th century thought was changing from what had been traditional up until the late 19th century.

District objectives addressed:

Students will contrast examples of scientific thought, painting, music and literature from the neoclassical period and from the early twentieth century.

(LA II--6; LA IV--1; LA V--1, 2, 5, 6)

Days Three and Four

Through visual presentation (transparencies and video clips) students will be introduced to Einstein's theory of special relativity. A brief review of Newton's Laws of Motion and definitions of absolute time and space will be given. These could be designed as sample mathematical equations, diagrams, verbal explanations or a combination of methods. Then an explanation of Einstein's two postulates will be given through transparency diagrams and a video explanation. Specific to this unit and the making of connections between Einstein and artists of the period will be the concepts of frames of reference, light as a constant, time dilation and the twin paradox and the Doppler shift of light. The first day will be presentational—lecture, demonstration and discussion. The second

day will include exercises and problems that the students will work on in pairs. These exercises can be found in Paul Hewitt's *Conceptual Physics* and Lewis Carroll Epstein's *Thinking Physics* (see Appendix A for sample questions).

District objectives addressed:

Students will analyze and evaluate information presented through various media regarding the disciplines of science, art, music, dance and literature at the beginning of the twentieth century (LA II—7; LA V—1, 2, 5, 6)

Days Five and Six

During the next two days students will view paintings, hear music, and view video clips of ballets from the modern period. The music will be played as the students are viewing the paintings or the ballet, and after each section of the presentation there will be a discussion during which the students will be encouraged to share their reactions to the music and the art work or ballet. Again, as during the introductory day, the students will attempt to describe the piece, and then synthesize their descriptors in an effort to describe the period.

Section combinations might include:

- Impressionism/Debussy
- Post impressionism/Rachmaninoff
- Isadora Duncan/Bartok
- Cubism/Shostakovitch
- Clips from *The Firebird* Ballet/Stravinsky
- Futurism and Surrealism/Copland
- Martha Graham/Appalachain Spring

District objectives addressed:

Students will analyze and evaluate information presented through various media regarding the disciplines of science, art, music, dance and literature at the beginning of the twentieth century (LA II—7; LA V—1, 2, 5, 6)

Day Seven

Students will be introduced to Modernism in literature with a discussion, notes, and samples of literature from 19th century romanticism and realism contrasted with some from 20th century modernism. Authors from the 19th century who could be used include Edgar Allan Poe, Herman Melville, Nathaniel Hawthorne, Walt Whitman, Emily Dickinson, Mark Twain, Stephen Crane and Bret

Harte. Comparisons could be made to selections from Ezra Pound, T.S. Eliot, Katharine Anne Porter, William Carlos Williams, and William Faulkner.

District objectives addressed:

Students will analyze and evaluate information presented through various media regarding the disciplines of science, art, music, dance and literature at the beginning of the twentieth century (LA II—7; LA V—1, 2, 5, 6)

Day Eight

Students will take a multi-media quiz wherein they will be shown samples from one of the two periods being compared, and they must decide which period the sample represents. The samples could come from ones already shown, or similar samples from the same scientists, authors or artists.

District objectives addressed:

Students will be able to articulate similarities in the concepts and ideas of the various disciplines of science, art, music, dance and literature at the beginning of the twentieth century (LA IV—1, 3)

Day Nine-Twenty Eight

Students will read, analyze and discuss *The Sound and the Fury* by William Faulkner. A brief biography and introduction to the novel will be given on the first day. Sample discussion questions follow in the appendix. The unit will culminate in an in class essay describing the *zeitgeist* of this period. Students will need to explain how scientists, artists and authors (especially Faulkner in this novel) helped to define what we think of as the early 20th century.

District objectives addressed:

- Students will read a novel and analyze, interpret and evaluate it with reference to style, content and merit (LA I—1, 3, 7, 8; LA II—1, 2, 3, 5, 6; LA IV—3; LA V—1,2,3,4,6,7)
- Students will write an essay that will explain the *zeitgeist* of early twentieth century America. (LA III—1, 2, 3, 4, 5)

Appendix A

Sample Discussion Questions for Einstein's Theory of Special Relativity

This is just a brief sample of the types of questions that could be used in a group situation to stimulate discussion regarding the principles

that each question represents. Students could be asked, in small groups, to come up with the appropriate answers and give reasons as to why. Then a full class discussion could follow.

(From the book *Thinking Physics* by Lewis Carroll Epstein, pp. 469-92)

- I. If you were traveling with respect to the stars at a speed close to the speed of light (186,000 miles per second) you could detect it because
 - a. your mass would increase.
 - b. your heart would slow down.
 - c. you would shrink
 - d. all of the above
 - e. you could never tell your speed by changes in yourself.
- II. You are standing near the middle of a long board, which, as you perceive it, falls such that the two ends strike the ground simultaneously. You, therefore, think the board falls FLAT. But Ms. Bright (who is dashing by you at near the speed of light) perceives end B striking the ground BEFORE end A and therefore thinks the board was TILTED to the right as it fell. Her perception is
 - a. true
 - b. false
- III. The Doppler frequency shift produced by you receding from a source of sound is the same as the shift produced by the source of sound receding from you.
 - a. true
 - b. false
- IV. The Doppler frequency shift produced by you receding from a source of light is the same as the shift produced by the source of light receding from you.
 - a. true
 - b. false
- V. A rocket ship in space emits brief flashes of light from its beacon at a steady rate of one flash every six minutes, rocket time. These flashes are observed on a distant planet at high speed. Observers on the planet will see the flashes at intervals
 - a. less than six minutes
 - b. six minutes
 - c. more than six minutes

(from Paul Hewitt's book *Conceptual Physics*, p.645 and 648)

1. If you are moving in a spaceship at a high speed relative to the earth, would you notice a difference in your pulse rate? In the pulse rate of the people back on earth?
2. Will observers A and B agree on measurements of time if A moves at half the speed of light relative to B? If both A and B move together at half the speed of light relative to the earth?
3. Does time dilation mean that time really passes more slowly in moving systems or that it only seems to pass more slowly?
4. If the spaceship travels for one hour and emits a flash every six minutes, how many flashes will be emitted?
5. The ship sends equally spaced 6-min. flashes while approaching the receiver at constant speed. Will these flashes be equally spaced when they encounter the receiver?
6. If the receiver sees these flashes at three minutes intervals, how much time will occur between the first and the last flash (in the frame of reference of the receiver)?

Both of these books contain many other questions (as well as full explanations) that would be beneficial in the teaching of the special theory of relativity. Another excellent source for similar activities is *Basic Concepts in Relativity and Early Quantum Theory* by Robert Resnick and David Halliday.

Appendix B

Discussion questions for Faulkner's *The Sound and the Fury*

Use of questions similar to these might help students to keep focused on the ideas and concepts discussed at the beginning of the unit, and help them to answer the essential question of how do the expressions of all of these great minds and talents connect to reflect the *zeitgeist* of the period of early 20th century America.

1. How is time perceived differently by each of the four narrators? Can you describe time in the perspective of each, or in the perspective of the other major characters?
2. What is time—ultimate reality or illusion?
3. What do you suppose is Faulkner's view of time?
4. How can the "stream-of-consciousness" narrative style be compared to Einstein's exclusion of a preferred frame of

reference?

5. How does Faulkner's style reflect the *zeitgeist* of Early 20th Century America?

Documentation

Annotated Teacher Bibliography

Abbott, Edwin A. *Flatland: A Romance of Many Dimensions*. 5th ed., rev. New York: HarperCollins, 1983.

Interesting fictionalized account, originally published in 1923, of the fourth dimension by Shakespearean scholar.

Asimov, Issac. *Understanding Physics*. vol. I. Dorset Press, 1966.

User-friendly for the non-scientist.

Canaday, John. *The Nuclear Muse*. Madison, WI: The University of Wisconsin Press, 2000.

Very interesting look at the scientists and the events in and around the Manhattan Project.

Daniel, Kathleen, et. al., eds. *Elements of Literature: Fifth Course. Literature of the United States with Literature of the Americas*. Austin: 2000.

Durell, Clement V. *Readable Relativity*. New York: Harper and Row, 1926.

Interesting approach to understanding relativity written not too long after the original papers were published.

Einstein, Albert, et. al. *The Principle of Relativity*. Trans. W. Perrett and G.B. Jeffery. New York: Dover, 1923.

Einstein's original papers defining his theories.

Epstein, Lewis Carroll. *Thinking Physics*. San Francisco: Insight Press, 1990.

A wonderful collection of conceptual exercises to help explain physics.

Hawking, Stephen. *A Brief History of Time*. New York: Bantam, 1998.

Bestseller describing developments in

physics taking us to contemporary times.
Written for the non-scientist.

Hewitt, Paul G. *Conceptual Physics*. 8th ed. Reading, MA:
Addison-Wesley, 1998.

Excellent student textbook.

Lightman, Alan. *Great Ideas in Physics*. New York: McGraw-Hill,
2000.

Lecturer from MIT in both physics and
humanities talks about the connections
between them.

*The Mechanical Universe: Quad VII, "The Special Theory of
Relativity"*. The Annenberg/CPB Project. Videocassette. California
Institute of Technology and Southern California
Consortium, 1989.

Series of videotapes created for a university
classroom and adapted for high schools.
Very good description Minkowski's
time-space diagram.

Miller, Bernard. *The Humanities Approach to the Modern Secondary
School Curriculum*. New York: The Center for applied
Research in Education, 1972.

An older, but interesting description of and
need for a humanities curriculum.

Minter, David, ed. *A Norton Critical Edition: William Faulkner's The
Sound and the Fury*. New York: W.W. Norton and Co.,
1994.

An excellent edition. Critical analysis is
very complete.

Newton, Issac. *The Mathematical Principles of Natural Philosophy*.
New York: Citadel Press, 1964.

Newton's original work. Very difficult reading, but very
necessary to understand what he actually wrote.

Riechers, Maggie. "Streetwise Socrates." *Magazine for the National
Endowment for the Humanities*. June/July, 2000. National
Endowment for the Humanities. Aug. 2000
<http://www.neh.fed.us/news/humanities/2000-05/clemente.html>

Interesting story about a very beneficial program in the humanities for the poor in New York.

Resnick, Robert and David Halliday. *Basic Concepts in relativity and Early Quantum Theory*. 2nd ed. New York: Macmillan, 1992.

Good student exercises for students in physics.

Shlain, Leonard. *Art and Physics: Parallel Visions in Space, Time and Light*. New York: Quill, William Morrow, 1991.

Interesting comparisons between artists and physicists. Shlain's theory is that artists and scientists have had immense influence on each other throughout history.

Spiller, Robert E., et. al. *Literary History of the United States*. 4th ed. New York: Macmillan, 1974.

Excellent survey work describing major literary movements throughout American history.

Sporre, Dennis J. *Reality Through the Arts*. 4th ed. New Jersey: Prentice Hall, 2001.

Fine humanities text with brief descriptions of various periods of development in visual art, music, architecture, literature, and theatre.

Taylor, Edwin F. and John Archibald Wheeler. *Spacetime Physics*. New York: W.H. Freeman and Company, 1992.

Helpful student questions and exercises—though a bit too advanced for a unit such as this.

Vargish, Thomas and Delo E. Mook. *Inside Modernism: Relativity Theory, Cubism, Narrative*. New Haven: Yale University Press, 1999.

Excellent, and very helpful comparisons made on the theory that each of the three disciplines listed are closely connected in their impact on society.

Inside Relativity. Princeton: Princeton University Press, 1987.

Very readable explanation of relativity for non-scientists by a physicist and a literature scholar.