Introduction
Students in the eighth grade in the archdiocese of Philadelphia are expected to have some knowledge about the composition, magnitude, and life cycle of stars. As a member of the committee that compiled these requirements, I know that there was a great deal of discussion about the depth into which students should be expected to delve.

For the last twenty some years, it has been my responsibility to work with students to develop their understanding of the solar system, galaxy, and universe. This is no small task that is further complicated by the fact that I am aware that most of my students will never have another formal course in astronomy. I am fascinated by the study of space and all that is beyond the Earth’s atmosphere but then again I am a child of the 1960’s – the “Space Race” and all that it entailed was more than a phrase to me because my own father played a part in the advancement of the United States through his job at the General Electric.

This has always been the unit I most look forward to but in recent years, I have come to realize that there are many students out there who are not impressed by space exploration – some don’t even believe man has set foot on the moon! In addition, many students believe you cannot learn astronomy during the day because you can only study galaxies, constellations, and the stars at night.

My professional goal for this lesson is: to engage students’ interest in the study of the universe – not only for the sake of passing a test but also for the satisfaction of looking at the night sky (daytime sky will be addressed with my students at other points during this unit) with wonder, fascination, and awe. Perhaps this is an unrealistic educational goal, but if I don’t put it in writing, will I really try to do it?

Epistemology
How do my students come to know? Until this year, I have not spent a great deal of time thinking about this. Occasionally some random professional development course or new direction that the archdiocese has chosen to adopt will require me to think about this but often this is tangled up with more basic skills or improving the math scores or using more hands-on or flexible grouping or something else.

I am aware that students in the 21st century at St. Timothy School are no longer content to sit and listen to an adult. Reading a textbook (aloud or alone) and answering a series of main idea questions does not cut it either. Hands-on and inquiry activities are not always the best for all students either. Students must be able to think critically in order to complete tasks as well as to explain what the results of the activity mean.

In science class, I am trying to work with two basic ideas put forth by the Archdiocese of Philadelphia in the last two years. First, I am working on creating lessons that
encourage higher level/critical thinking skills. Second, I am working on creating lessons that are more in tune with the everyday world of our students. All of this is combined with the Rigor and Relevance program.

I find that both of these are very difficult to me personally. Mostly I find it difficult because my personal learning style urges me to listen, make copious notes on any lecture and reading, further my knowledge by reading other resources, and getting good grades on objective testing. I don’t like to have to write essays (although I have been told that I express myself well) because they are too ambiguous. I am afraid of offending the teacher or administrator for whom I am writing the assignment. In the same way, I don’t like to assign essays because I’m afraid of hurting the child’s feelings if they don’t have good communication skills when I’m responsible to assign a grade for math or science.

I would like to set a good example to the other teachers in my school by offering my own students more hands-on activities to support the concepts that I teach but I am afraid to really let them inquiry because sometimes I am insecure in my knowledge of the science they are studying.

Methodology
I have enclosed a copy of the activities that I will be using to work with the students so that they can construct their own understanding of how the composition of stars and their size will affect their life cycle. The textbook that is my primary source of information for the students is the Prentice-Hall Earth Science Explorer circa 2002. I expect this chapter that connects stars to galaxies and the universe to take approximately eight class days this year (which is twice as long as in previous years) and I anticipate starting around March 1. I will be using all the activities with the one class that is my demonstration group. I plan to use some of the activities with all three classes but I would like to see both quantitatively and qualitatively whether or not the activities I have planned change the perception of the students in the demonstration group about the study of the stars compared to the other two groups.

Constraints to Curriculum

- **State/Local Standards and Benchmarks:** As previously stated, the concepts of composition, magnitude, and life cycle of stars are presented in the archdiocese eighth grade guidelines. State standards, as well as national standards are far less specific.
  - PA State Standard 3.4.7.D - Describe essential ideas about the composition and structure of the universe and the earth’s place in it.
  - PA State Standard 3.2.7.B - Apply process knowledge to make and interpret observations.
- **Perspectives on Teaching and Learning:** My personal perspectives on teaching and learning at this point in my career are expressed in my
position paper which has already been presented (and is included here as appendix A).

- **Scope and Sequence:** It is generally expected that I would complete the entire unit on astronomy within approximately the second half of the second trimester (six weeks). In using the textbook series as my basic source of information, I have always taught the chapter on the Earth and moon followed by the chapter on the solar system, followed by the chapter on stars, galaxies, and universe.
  
  - Explore students' alternative frameworks – While some of my students are interested in astronomy more than any other branch of Earth Science, there is a group of students each year who claim that we cannot study astronomy because it isn’t nighttime.
  - History of Chemistry as it applies to the study of the stars – The Chemistry 511 project will be detailed in the ‘background activity’ section of this paper.
  - Discover activity on the perception of distance in space.
  - Discover activity on the ability of light waves to travel through space.
  - Spectroscopy
  - Vocabulary development
  - Experiment: Flame Test – to allow students to develop a sense of color versus temperature as well as spectra as a means of identifying the composition of far-off objects in space.
  - Introduction of the Hertzsprung-Russell diagram.
  - Development of a Life Cycle Sequence for stars based on information gathered.
  - Assessment – Jewel Box Cluster – use knowledge of color, size, and temperature relationships to determine the age of a galaxy.

- **Filters:** Using the Understanding by Design template:
  
  - Stage 1 – Desired Results: Students will be able to describe essential ideas about the composition and structure of the universe and the Earth’s place in it (PASS 3.4.7.D)
    - Students will understand that stars are masses of gas of various sizes and distances from the Earth.
    - Students will understand that the size of a star determines its eventual “death” phase.
    - Students will know how to catalog information about distant objects (stars) using graphs, charts, and spectroscopy.
  - Stage 2 – Assessment Evidence: Students will be able to determine the age of a given galaxy through the analysis of a star chart and gauge.
    - Students will be able to interpret and discuss the results of various activities.
    - Students will ask questions of one another.
  - Stage 3 – Learning Plan: *see scope and sequence above.*
Understanding by Design

STAGE ONE – Desired Results

Established Goals: Students will be able to describe essential ideas about the composition and structure of the universe and the Earth’s place in it. (PASS 3.4.7.D)

What essential questions will be considered?

• How do we know the composition of the stars?
• How and when will the Sun “die”?

What understandings are desired?

• Students will understand that stars are masses of gas of various sizes and distances from the Earth.
• Students will understand that the size of a star determines its eventual “death” phase.
• Students will understand that gases emit characteristic spectra.
• Students will understand the difference between red and blue shift as a means to determining movement in space.

Knowledge:

Key Terms: spectrum, spectrograph, parallax, absolute magnitude, white dwarf, supernova, spiral galaxy

Key Ideas:

• The electromagnetic spectrum includes radio waves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.
• The main characteristics used to classify stars are size, temperature, and brightness.
• The length of a star’s life depends on its mass.
• About five billion years ago, a cloud of gas and dust collapsed to form the solar system.

Skills:

• Students will be able to use computer generated models to observe the wavelength of light.
• Students will be able to correctly identify elements based on their spectra.
• Students will be able to read and interpret the Hertzsprung-Russell diagram.
• Students will be able to infer the usefulness of parallax as distance increases.

STAGE TWO – Assessment Evidence

Performance Tasks:

• Star Light, Star Bright – Interactive computer program that allows students to learn and explore the electromagnetic spectrum. http://amazing-space.stsci.edu/eds/overviews/explorations/
• Flame Tests – Observe the flame colors of spectral salts. In conjunction with the use of diffraction gratings, students will be able to observe visible light waves. http://www.creative-chemistry.org.uk/activities/flametests.htm
• **How Old Are the Jewels** – Plot color and brightness of individual stars to determine the approximate age of the galaxy.
  
  [http://www.noao.edu/education/jewels/home.html](http://www.noao.edu/education/jewels/home.html)

**Other Evidence:**

• **Parallax** - Stand facing a wall, at least an arm’s length away. Stretch your arm out with your thumb up and your fingers curled. Close your right eye and look at your thumb with your left eye (line your thumb up with something on the wall). Now close your left eye and open your right eye. How does your thumb appear to move along the wall? Bring your thumb closer to your eye, about half the distance as before and repeat.

• **Diffraction Grating** - After the introduction of what prisms and diffraction gratings are, allow students to examine light using diffraction gratings. If possible examine fluorescent light, incandescent light and natural light. Ask students to reflect upon the differences in the spectra and the reasons why these differences might be evident.

• **Self-Assessment/Reflection** – Students will have the opportunity to write a reflection that summarizes the experiences offered as well as to offer critical observations for the teacher that will allow her to improve upon the lesson.

**STAGE THREE – Learning Plan** – see above

**Analysis of Lesson**

I am not by nature a contemplative person. I like to read and I like to organize and plan but I don’t generally take the time to think about the whys and wheres and whos and hows. These to me are mysteries that I don’t venture to solve.

As a result of this class, Teaching and Learning Middle School Science, I have had to attempt more introspection as I planned my lessons. I needed to learn just how to approach new topics with new presentations and to anticipate how they would turn out so that I would be able to evaluate them.

My three classes of students were all quite receptive to trying new tools for science. We used the laptops for the explorations of waves. They were exceptionally good at navigating the site because they were accustomed to using them with my grade partner in both social studies and religion. They were clearly pleased with the inquiry nature of the site to which they were sent and they stayed on task.

The diffraction gratings were more troublesome. Since they were relatively inexpensive, the quality was not great but once a few of the students managed to manipulate them successfully, they were quiet excited trying to see the different spectra for fluorescent, incandescent, and natural light. This was especially difficult because the day of the observation was mostly overcast and they had to “catch” the sun when it was there.
They seemed bemused by the idea that they could (and should) get up out of their seats to get better results with the tools.

The flame test was included with this lesson so that the students could see that different substances gave off different colors. While this did not directly relate to the temperature versus color of the Hertzsprung-Russell diagram and the classification of stars, I used this experience to clarify to the students that there were visible differences that could be seen without specialized tools. This was important to those students who still weren’t sure how we could be studying the night sky during the day. Two of the three classes, when their data was pooled, were able to correctly determine which samples were which. I believe that the third class was unsuccessful because I did not thoroughly clean the wires between classes which may have resulted in cross contamination.

I was gratified to see the industry of my students during the evaluation of the Jewel Box cluster. More than ninety percent of the students were able to correctly determine that the Jewel Box Cluster is a young galaxy.

This was a thoroughly positive experience for me as a teacher. The students assured me that they also thought it was a pretty good way to learn about the stars – but they do tend to tell me what they think I want to know. I will be using some of these activities again next year with some refinements.

School Ethnography

SOCIOLGY AND CULTURE OF THE SCHOOL - St. Timothy School

St. Timothy School, located in the Mayfair neighborhood of northeast Philadelphia, serves approximately 850 children in grades pre-kindergarten through eight. This is an urban, blue collar area that has undergone some intensive socio-economic change in the past eight to ten years.

St. Timothy is primarily a parochial school for an area of one and a half miles in all directions. Over the last two years, we have also incorporated the students from two neighboring parochial schools that closed in Tacony and Wissinoming. The original families of St. Timothy Parish, almost exclusively white Catholics of Irish, German, and Italian descent, stayed in the parish/neighborhood for generations. The diversification over the last decade is small but noticeable: 6.25% of the students are Hispanic with another 4% who are Asian or Black. In the past, it was the rare non-catholic child who attended St. Timothy School; this year’s roll includes 6% non-catholics. Since part of the culture of our school is faith-based this is a significant shift.
More than half of the twenty-eight full-time faculty members have taught at St. Timothy for at least 15 years, accumulating an impressive 380 years of experience in this school by 17 faculty members. This experience breeds a wonderful stability but it can hamper change — our school culture is one mired in “tradition” — implementation of new ideas, events, or experiences is often difficult.

The physical property that makes up St. Timothy School is one large square block. Three conjoined buildings house the school. The oldest building is where grades one to three are located as well as the CORA counselor, the CORA and Title I teachers, the speech therapist, and the DRE (Director of Religious Education). The middle building, in both age and area, houses the administrative offices, grades 7 and 8, the nurse, the computer room, the music room, the art room, the science room, and the library. The newest building was built in 1962 to attach directly to the convent (with an elevator to serve both). It is attached to the other school buildings by the “bridge” — an enclosed suspension, made necessary by the incline of the property - that allows the students and faculty to move to the new building without confronting bad weather. It is in this building that the kindergarten, grades 4 to 6 and the gym/auditorium are located. The property also has a church (upper and lower churches actually) and a rectory for the priests.

SOCIOLOGY AND CULTURE OF THE CLASSROOM - Grade 8 – 2007

This year I am again teaching eighth grade – math and science. There are three homerooms of eighth grade (33 students in each). One grade partner teaches integrated language arts (this course “integrates” grammar, spelling, vocabulary, and writing skills with the reading anthology and trade books). The other grade partner teaches social studies and religion.

The sociological makeup of each class is a reflection of the school. The students are mostly well-adjusted middle class kids who have the latest toys and technology. This is an area of the city that invests a great deal of childhood in organized sports – neighborhood athletic clubs and CYO (catholic youth organization). Students and parents rank participation in athletics higher than achievement in academics.

Beyond athletics, however, the class of 2007 is not a class of joiners. Many school activities are run by seventh graders because this class does not have the interest in leadership or in being the center of attention on a broader stage. In the classroom, they would prefer to learn new ideas or concepts with a minimum of fuss, less participation, and no homework if they could manage it. This is unusual for the school. Although students rarely want homework, previous classes have been participators. On the positive side, this class has fewer cliques and far fewer ostracized members than other classes. They are not overtly disrespectful but they do lack self-control. They have difficulty knowing when to stop talking and when to start listening. My interaction with them is largely positive because I don’t allow them to upset the structure of my lesson – I am flexible when topics digress, but I don’t often raise my voice.
CORA Services provides reading support for five students and math support for another four. Title I services are provided for seven students with reading/language weaknesses. Only one of the ninety-nine students has a diagnosed learning disability – auditory perception. He is working with remarkable ease in eighth grade and his mother is especially careful to foster his progress by allowing him to make some decisions on his own now that he must get ready to attend high school.
APPENDIX A

Position Paper

I am an educator in my thirty-third year of teaching. I pride myself on being a lifelong learner willing to attempt new things for my own sake as well as my students’. I am a voracious reader – it is indicative of my own learning style that I’d rather read than do almost anything in the world (except travel). When I am interested in a topic, I go find out all I can from books and magazines. I make lists and notes and create meticulous records of information so that I can refer to it as needed.

I had expected to be an early childhood teacher (they used to call it primary teacher). However, in September 1984 I moved from teaching fifth grade to teaching eighth grade. I had discovered a rapport with middle school students and so I have been teaching in eighth grade since then – twenty-three years. I have been a reading teacher, a religion teacher, the integrated language arts teacher, recently the math teacher, but in addition to all of these positions, I have also been the science teacher – I often like to say the “accidental science teacher.” St. Timothy School was considered to be a very progressive, cutting-edge institution in the 1970’s. Departmentalization was in place in grades three to eight. Unfortunately, science was the one subject that no one wanted to teach. It was usually thrust upon the newest grade partner. Thus when I arrived in 1977, I was expected to take on – but loathe – the subject; surprisingly, I came to enjoy it.

Epistemology

How do students come to know? In my research in the past few months about epistemology, I have come to the conclusion that people (students) come to know or learn in many different styles, experiences, and through the use of various teaching styles that support them.

In any one classroom, the random mix of students is such that it would be impossible for one teacher to meet all the learning style needs in one class period. In this respect, I particularly like the backward design template presented by Wiggins in Understanding by Design, 2nd Edition (p.22). By establishing the desired outcomes first, I know better how to assess my students and what assortment of learning experiences will allow all to achieve.

In the first chapter to How People Learn, the editors outline changing theories in how to educate: from basic skills to behaviorism to cognitive science, et al. One fascinating statement stood out to me in my role as curriculum coordinator:

“Above all, information and knowledge are growing at a far more rapid rate than ever before in the history of humankind. As Nobel laureate Herbert Simon wisely stated, the meaning of "knowing" has shifted from being able to remember and repeat information to being able to find and use it (Simon, 1996). More than ever, the sheer magnitude of human knowledge renders its coverage by education an impossibility; rather, the goal of education is better conceived as helping students develop the intellectual tools and learning strategies needed to acquire the knowledge that allows
people to think productively about history, science and technology, social phenomena, mathematics, and the arts. Fundamental understanding about subjects, including how to frame and ask meaningful questions about various subject areas, contributes to individuals’ more basic understanding of principles of learning that can assist them in becoming self-sustaining, lifelong learners.”

**Nature of Science**

I believe that the nature of science is the ability to study the world around us so that we are able to more easily understand our place in it. A few months ago, I said that I wasn’t even sure that I had ever really thought about the nature of science. I currently believe that the nature of science is the ability to question, quantify, analyze, and summarize the world as we know it. It requires much more from a science teacher than any other subject requires because it asks educators to suspend the control on facts (of which many in elementary and middle school teachers only have a tenuous grasp anyway) and allow students to reconstruct ideas as they come upon things that no longer make sense. It asks us to become involved with the world in a way that no other curricular area compels.

Unfortunately, I do not find that the public at large cares about science education. I could go a step further to state that in many schools, teachers don’t care about science education – and I don’t mean the facts of science, I mean doing a good job of encouraging students to observe the world and to be fascinated by it. It is the first subject to be cut out of the school day when there is a special schedule. Recommended teaching minutes are lower than all academic areas in most districts. As the chairperson of the Archdiocesan Elementary Science Committee, I have had to fight over the years to make sure that the minimum is met. In addition, I am obliged to tell school administrators and curriculum coordinators of science that the TerraNova test we use is largely a literacy test of reading and math skills.

**Role of Science Education**

In 1996, the National Research Council in the National Science Education Standards stated: “A sound grounding in scientific inquiry strengthens many of the skills that people use every day, like solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing life-long learning.” (p.ix) I perceive this as a lofty goal for elementary/middle school teachers when they have the conflicting perspective of standardized testing goals and basic skills mandates.

A few weeks ago, I was in the doctor’s office and happened to pick up the *Time* magazine issue from December 10, 2006. The article title alone was intimidating: “How to Bring Our Schools Out of the 20th Century” so needless to say the image that authors Wallis and Steptoe presented was daunting.

“This is a story about the big public conversation the nation is not having about education, the one that will ultimately determine not merely whether some fraction of our children get "left behind" but also whether an entire
generation of kids will fail to make the grade in the global economy because they can't think their way through abstract problems, work in teams, distinguish good information from bad or speak a language other than English.”

Role of Science Educator
As far back as 1984, when I became a member of the Elementary Science Curriculum committee, I have been asking myself how I can become the best science teacher I can. These are the thoughts that I have developed for myself:

- Be prepared: know more than you think the students will want to know so that you can “dazzle” that special student with the spark of an interesting tidbit.
- Be creative: try new lessons, don’t stick to the same lessons year after year because it is not only boring but destructive to your students and to you.
- Be inquisitive: be a life-long learner – there is new science every day. Find an area that interests you and read or keep your mind awake to all areas of progress and explore. Take classes, go to lectures, become a member of a scientific association, attend a national association conference to meet like minded educators.
- Be the facilitator: give your students time to think, discuss, plan an experiment that supports their understanding. You probably have wealth of patience that you haven’t spent yet.
- Be the motivator: give your fellow teachers some new ideas, get excited, find a way to support the insecure and champion the innovative members of the faculty.

One rather pertinent revelation that has come to me from this class is that inquiry and hands-on science are not synonymous. While hands-on science is one type of inquiry, not all inquiry is hands-on. This has importance to me because I do have very serious time and space constraints in my science classes. I must learn to provide additional types of inquiry so that my students can develop critical thinking and problem solving skills. In addition, I have learned that hands-on without reflective practice does not really accomplish as much as I had thought. My students may “enjoy” the experience but I am obligated to foster learning with each encounter with science.
Bibliography

http://astro.u-strasbg.fr/~koppen/discharge/
http://www.creative-chemistry.org.uk/activities/flametests.htm
http://fuse.pha.jhu.edu/~wpb/spectroscopy/tool.html
http://fuse.pha.jhu.edu/~wpb/spectroscopy/em_spec.html
http://imagine.gsfc.nasa.gov/docs/science/know_12/multiwavelength.html
http://imagine.gsfc.nasa.gov/docs/teachers/elements/
http://imagine.gsfc.nasa.gov/docs/teachers/lifecycles/stars.html
http://instruct1.cit..cornell.edu/courses/astro101/java/evolve/evolve.htm
http://laserstars.org/bio/astronomers/html
http://laserstars.org/spectra/
http://personal.tcu.edu/~dingram/edu/pine.html
http://www.thespectroscopynet.com/Educational/Colour.htm
http://www.thespectroscopynet.com/Educational/Diffraction.htm
http://www.thespectroscopynet.com/Educational/Light.htm
http://www.thespectroscopynet.com/Educational/Rainbow.htm