INCORPORATING MULTIPLE INTELLIGENCE THEORY INTO SCIENCE INSTRUCTION

A Project

Presented to the faculty of the Department of Teacher Education

California State University, Sacramento

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF ARTS

in

Education

(Curriculum and Instruction)

by

Courtney Harrison Eller

SPRING

2013
INCORPORATING MULTIPLE INTELLIGENCE THEORY INTO SCIENCE INSTRUCTION

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by

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Department of Teacher Education
Abstract

of

INCORPORATING MULTIPLE INTELLIGENCE THEORY INTO SCIENCE INSTRUCTION

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Courtney Harrison Eller

Statement of Problem

No Child Left Behind Act has led to high stakes testing and a one size fits all curriculum. Many teachers only focus on reading, writing, and arithmetic and even though they know, there are many other ways to learn. It is important for teachers to emphasize other ways of learning for student success. Howard Gardner asserts that every child has various intelligences for learning. The more teachers nurture all the various intelligences, the better for acquisition of knowledge and skills by the student.

Sources of Data

An evaluation of research from the areas of education and psychology, including researchers such as Howard Gardner, Caroline Tomlinson, David H. Rose and Anne Meyer was utilized.
Conclusions Reached

Multiple Intelligences Theory focuses on the many different ways students learn. The application of this theory in the classroom allows all students to have success.

This curriculum incorporates this theory into an astronomy unit as well as the theories of Differentiated Instruction and Universal Design for Learning. The unit can be used in any eighth grade, California science classroom or be adapted into another grade level in any state.

_______________________, Committee Chair
Rita M. Johnson, Ed.D.

_______________________
Date
DEDICATION

This project is dedicated to the millions of teachers who sacrifice much of who they are to help young people learn and apply the skills needed to be citizens and life-long learners.

This is also dedicated to my husband, Scott Eller, who helped me tremendously throughout this process with support and encouragement.
ACKNOWLEDGEMENTS

This work is a result of the contributions of time and effort of many people. I thank the faculty and staff of the Department of Teacher Education at California State University, Sacramento. Dr. Rita Johnson played a pivotal role in the creation and competition of this project. Her guidance and encouragement were invaluable. Dr. Frank Lilly also provided great motivation and assistance to create the body of this work.

I would also not have been able to accomplish this without the help and support of numerous family members, as well as fellow colleagues. Immense appreciation goes to my dear husband, Scott Eller, who provided me with unconditional encouragement, confidence and support.
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Chapter 1

INTRODUCTION

She stares out the window and observes leaves rustling in the wind. In her notebook, she doodles pictures of the leaves in flight. Upon closer inspection out of the window, she notices the leaves are beginning to change colors to red, orange, and yellow. She wonders why leaves change color. Why does the temperature change? Why do days get shorter? Fall is approaching; school is in session; however, there is no more time for observing nature and asking questions. The time is for memorizing facts and not asking why. The time is for filling in bubbles and not drawing pictures. The time for creativity is over.

Statement of the Problem

There has been much debate about The No Child Left Behind Act, which requires students to show proficiency in subject matter by passing state or national tests (Noll, 2012). The increase in high stakes testing has pushed teachers to teach to the test using repetitious instruction, leaving little time for creativity or project-based inquiry (Nichols & Berliner, 2008). Research demonstrates that verbal and logical-mathematical intelligences are the best predictors of overall intelligence (Swami, Furnham, & Kannan, 2006), which explains why 70% of the national curriculum is verbal-linguistic and logical-mathematical (Garzitto, 2010). However, this type of curriculum causes many learners to struggle to perform, thus widening the achievement gap (Garzitto, 2010). The Multiple Intelligences (MI) theory functions as a “remedy to one-sidedness in teaching” and “acts as an organizational tool that
facilitates and synthesizes existing educational pedagogy” (Stanford, 2003, p. 82).

Differentiated Instruction (DI) focuses on individualizing instruction for each student by systematically planning instruction to honor each student’s learning needs and maximize each student’s learning capacity (Van Garderen & Whittaker, 2006). Universal Design for Learning (UDL) uses technology in education to improve pedagogy for students with and without disabilities (King-Sears, 2009). To serve all students and learners, educators should integrate MI theory, DI and UDL into the curriculum, in every classroom, so that every learner can have success.

**Purpose of the Project**

The purpose of this project is to create a curriculum that incorporates the MI theory, DI and UDL framework with the eighth grade California science standards, so that all learners can have access to the curriculum and achieve. This project will create a curriculum, using DI embedded in the UDL framework, including formative and summative assessments, detailed lesson plans, and student handouts for a three to four week unit integrating MI theory with the eighth grade California state science standards.

**Significance of the Project**

UDL is a framework for integrating flexible, usable, and accessible teaching and learning technologies with standards-based curricula rather than retrofitting or modifying existing curriculum materials (Curry, Cohen, & Lightbody, 2006). Brand, Favazza, and Dalton (2012) describe UDL as a “tangible means by which educators implement the special education requirements” while realizing the importance of
providing natural curricular provisions for all individuals (p. 134). UDL does not require the purchase and use of the latest technology; however, resourceful teachers enlist a variety of materials and learning experiences that involve learners in meaningful ways (Brand et al., 2012). Therefore, the aim of UDL is to make “educational environments seamlessly and inherently functional for the widest number of learners” (Curry et al., 2006, p. 33).

Limitations

The curriculum created by this project will only use California State Standards for eighth grade science. Therefore, alterations may be necessary for success in other learning environments. In addition, the adoption of the common core will occur after the creation of this curriculum. The curriculum will not incorporate these new standards.

Theoretical Basis of the Project

The theoretical basis of this project is constructivism. Constructivist learning theory says that learners create meaning of the world around them by engaging in first hand experiences, which then give the learner reliable, trustworthy knowledge and understand by building on previous learning (Smith & Throne, 2009).

Definition of Terms

Achievement: is a student’s score on a high stakes test and/or the grade on a content test.
Bodily-kinesthetic intelligence: is the ability to solve problems or create products by using one’s whole body or parts of the body. This person learns best by role playing, dancing and/or working with his or her hands (Gardner, 1983, 1999).

Differentiated Instruction: is teaching flexibly in order to match instruction to student need with the goal of maximizing the potential of each learner (Tomlinson, 2003).

Existential: is the ability to relate self to the world and see the big picture. This person learns best by reflecting or discussing philosophical questions (Gardner, 1999).

Formative Assessment: are activities undertaken by teachers, and/or by their students, which provide feedback to modify the teaching and learning activities (Taras, 2009).

Graphic Organizers: is the process of reflecting the structure of a text in a visual chart (Campbell, Campbell, & Dickinson, 2004).

Intrapersonal intelligence: is the ability to understand one’s own personal feelings, strengths, and weaknesses (Gardner, 1983, 1999).

Interpersonal intelligence: is the ability to understand other people: What motivates them, how they work, or how work cooperatively with them? This person learns best in a group or with a partner (Gardner, 1983, 1999).

Learning styles: are the particular styles in which a person learns most effectively and can express learned knowledge (Levy, 2008).
Logical-mathematical intelligence: is the ability to learn and express knowledge in an orderly and logical method. This person learns best with logic, reason and numbers (Gardner 1983, 1999).

Multiple Intelligences (MI): are the nine areas that Howard Gardner described the mind as possessing (verbal-linguistic, logical-mathematical, visual-spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, natural, and existential) (Gardner, 1983, 1999).

Musical intelligence: is the ability to learn and express knowledge musically. This person learns best by using music, sound and rhythm (Gardner, 1983, 1999).

Naturalistic Intelligence: is the ability to learn and express knowledge in relation to nature. This person learns best by interacting with the world outside in nature (Gardner, 1999).

Summative Assessment: is an evaluation at the conclusion of a lesson or an activity to determine or judge student skills and knowledge (Taras, 2009).

Universal Design for Learning: a method of lesson planning that helps teachers create lessons that are effective for the broad range of students in their classrooms (Spencer, 2011).

Verbal-linguistic intelligence: is the ability to learn and express knowledge with language. This person learns best by using words, writing, reading, and listening (Gardner, 1983, 1999).
Visual-spatial intelligence: is the ability to learn and express knowledge by forming a mental spatial model. This person learns best by using pictures and graphic organizers (Gardner, 1983, 1999).

Organization of Project

The first chapter introduces the project. It includes the statement of the problem, the purpose and significance of this project, the author’s theoretical perspective, limitations of the project, and definition of terms.

The second chapter reviews literature that is relevant to this project. The literature review will discuss the reasons for creating a MI theory based curriculum using DI and UDL as a framework. The review will begin by identifying the need to improve student achievement and discuss possible solutions to the problem. Next, the review will summarize the history of Howard Gardner’s MI theory and describe the nine intelligences. Evaluation of current research will determine the effectiveness of MI theory and identify the benefits and challenges of the theory. Then, there will be a discussion of the relevance and process of integrating MI theory in the classroom. Finally, theories relating to MI, namely DI and UDL, will be discussed.

The third chapter discusses the methods used by the author to create the curriculum. It explains the development of the curriculum which integrates Gardner’s multiple intelligences theory with the eighth grade California science standards. The curriculum consists of a unit based on the eighth grade California science standards, and includes formative and summative assessments, detailed lesson plans, and student
handouts. Chapter 3 will also discuss implementation of the curriculum in the classroom.

The fourth chapter discusses the author’s conclusions about the effectiveness of the curriculum. It includes recommendations to maximize effectiveness of the curriculum and offers analysis to the following research questions:

1. When writing curriculum, where does multiple intelligence theory incorporate best with the CA 8th grade science standards?

2. What effects can curriculum incorporating multiple intelligence theory have on student achievement?

The Appendix contains the curriculum overview, formative and summative assessments, lesson plans, and handouts for the curriculum. Following the Appendix is a list of references used by the author to develop this project.
Chapter 2

REVIEW OF LITERATURE

Introduction

The No Child Left Behind Act (NCLB) requirements for standards-based curricula and standardized assessment for all students have changed the focus of educational reform (Van Garderen & Whittaker, 2006). NCLB legislation mandates school systems to adhere to a curriculum that promotes academic growth (Douglas, Burton, & Reese-Durham, 2008). However, this mandate is causing teachers to standardize instruction, simply “cover” content, “teach to the test”, and compromise their conceptions of what constitutes best practice (Brimijoin, 2005, p. 255). The one-size-fits-all accountability tests spreading across our nation “dramatizes the importance of ensuring that all students have access to appropriate curriculum, engaging instruction, and supportive resources” (Brimijoin, 2005, p. 254).

Simultaneously, the Individuals with Disabilities Education Act (IDEA) require individualized education for students with disabilities in the least restrictive environment, which usually is the general education classroom (Van Garderen & Whittaker, 2006). By being aware of student differences and ways they learn, teachers will be able to better assess student progress. Teachers must incorporate strategies that will lead to increased academic performance for diverse learners.

Multiple Intelligence (MI) Theory, Differentiated Instruction (DI) and Universal Design for Learning (UDL) will meet the demands of standards based education and high stakes testing. Applying MI Theory in classroom curricula is
crucial for both the teachers and the students because it allows for a wider range of students to successfully participate in classroom learning (Isisag, 2008) by identifying the different ways a student is smart, not if they are smart (Douglas et al., 2008). DI uses ongoing assessment data to inform instruction, increasing the likelihood that students engage with content, develop in-depth understandings, and build the capacity to transfer learning to testing (Brimijoin, 2005). UDL is a framework that guides the development of curricula that meets the needs of all students (Van Garderen & Whittaker, 2006). The purpose of this project is to incorporate the theory of MI, DI and UDL into CA eighth grade science standards so that all students will be successful in the classroom and exhibit academic growth.

**Multiple Intelligences Theory**

**History of Multiple Intelligences Theory**

Historically, intelligence is the ability to perform well on linguistic and logical-mathematical problem solving otherwise known as intelligent quotient (IQ) tests (Wu & Alrabah, 2009). Over the years, IQ tests were often associated with success in school; however, currently there is a growing awareness that “intelligence is a complex construct” (Wu & Alrabah, 2009, p. 395). People have many kinds of abilities and strengths that traditional IQ tests cannot measure (Wu & Alrabah, 2009).

Howard Gardner (1983) theorizes that humans learn and process information in many different ways and attributes these differences to multiple intelligences. Gardner (1999) redefines intelligence as “biopsychological potential to process information that can be activated in a cultural setting to solve problems or create
products that are of value in a culture” (p. 33). The cultural setting could change from generation to generation, so Gardner believes that any one test may not be the ideal way to measure intelligence. Barrington (2004) says that Gardner’s “view of intelligence is inclusive because it is not culture-bound and accounts for differences in time and place” (p. 422).

**The Nine Intelligences**

Gardner (1983) first identified seven different intelligences; namely, logical-mathematical, verbal-linguistic, spatial, musical, bodily kinesthetic, interpersonal and intrapersonal. Since the inception of MI Theory, Gardner (1999) has introduced two additional intelligences, naturalistic and existentialist and suggests there may be more intelligences research has yet to uncover.

Some critics argue that abilities in music and art are merely talents, not intelligences (Barrington, 2004). Gardner (as cited in Barrington, 2004) counters by saying if we regard music and art intelligence as talents, then he would want to label ability in language and mathematics as talents too.

At Gazi University, Isisag (2008) evaluated the validity of MI Theory by taking inventory of the multiple intelligences of first and fourth year students in foreign language classes. The inventory consisted of ten statements correlated to each type of intelligence. The results found that no two students had exactly the same profile of intelligences, and every student possessed all the different intelligences to varying degrees (Isisag, 2008). This study supports the idea that every student is different; therefore, teaching should use a variety of methods.
Verbal-linguistic intelligence. Linguistic intelligence is “the capacity to use words effectively, whether orally (e.g. as a storyteller, orator, or politician) or in writing (e.g. as a poet, playwright, editor, or journalist)” (Saban, 2009, p. 860). This intelligence is “perhaps the most universal of the intelligences” because everyone learns to speak and most people learn to read and write (Isisag, 2008, p. 353). The adoption of the Core Curriculum; a project that integrated reading and writing into mathematics, history, science and technology based subjects, shows that linguistic intelligence is highly valued by schools of all levels (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Students are required to complete a variety of lessons geared toward language, such as, book reports, oral presentations, and research papers. When designing a verbal-linguistic lesson, it is important to use language that students can relate to and comprehend (Nolen, 2003). Teachers improve this intelligence by remembering to focus on the creative part of verbal use by having students write poetry, plays, editorials, or participating in a reader’s theater (McCoog, 2007).

Logical-mathematical intelligence. Another heavily emphasized intelligence in schools is the logical-mathematical. This intelligence is the ability to “use numbers effectively (e.g. as a mathematician, tax accountant, or statistician) and reason well (e.g. as a scientist, computer programmer, or logician)” (Saban, 2009, p. 860). The processes that use this intelligence are categorization, classification, inference, generalization, calculation, and hypothesis testing (Isisag, 2008). Students that display strength in this intelligence are often model students because they can easily follow
the logical sequence of the classroom lesson (Nolen, 2003). Some sample activities to enhance this intelligence include making a graph or chart, work to recognize patterns, or put objects in a logical order.

**Spatial intelligence.** The spatial intelligence is “the ability to perceive the visual-spatial world accurately (e.g. as a hunter, scout, or guide) and perform transformations on those perceptions (e.g. as an interior decorator, architect, artist, or inventor)” (Saban, 2009, p. 860). Students with this intelligence may enjoy drawing pictures, painting, figuring out puzzles, designing a model, reading a map, or taking things apart and putting them back together again (Isisag, 2008; Rettig, 2005). It is important to note that though the spatial intelligence has a long list of abilities; one may not be strong in all of the skills listed. For example, a person may be strong with visual perception, but lack the ability to draw, imagine, or transform or vice versa (Nolen, 2003). To improve this intelligence, educators can teach using pictures, photographs, films diagrams, and other visuals (Nolen, 2003).

**Bodily-kinesthetic intelligence.** The bodily-kinesthetic intelligence is described as being an “expertise in using one’s body to express ideas and feelings (e.g. as an actor, a mime, an athlete or dancer) and facility in using one’s hands to produce or transform things (e.g. as a craftsperson, sculptor, mechanic, or surgeon)” (Saban, 2009, p. 860). Students that are strong in this intelligence will demonstrate good hand-eye coordination and may communicate through gestures. To nurture this intelligence, teachers should provide opportunities for students to use their hands and bodies to do the work (Isisag, 2008). Suggested activities by Lamb (as cited in McCoog, 2007)
include video productions, virtual field trips, and personal digital assistants (PDAs) for data collection (McCoog, 2007).

**Musical intelligence.** Musical intelligence is “the capacity to perceive (e.g., as a music aficionado), discriminate (e.g., as a music critic), transform (e.g., as a composer), and express (e.g., as a performer) musical forms” (Saban, 2009, p. 860). Students with this intelligence do not only remember music easily, “they cannot get it out of their minds” (Isisag, 2008). The musical intelligence is closely tied to logical-mathematical because of the inherent rhythm, ratios, and patterns found in music (McCoog, 2007; Nolen, 2003). Poetry is also an example of a musical medium because poetry is composed of sound elements and rhythm (Sword, 2007). To enhance this intelligence, students may enjoy listening to nursery rhymes, using interactive books, and experiencing video or audio recordings (McCoog, 2007; Rettig, 2005).

**Interpersonal intelligence.** The interpersonal intelligence is the ability to understand, perceive and discriminate between people’s moods, feelings and motives (Nolen, 2003). Professions that display this intelligence include teaching, politics, religious leaders, salesperson, therapists and counselors (Nolen, 2003; Shearer & Luzzo, 2009). Typically, students with strengths in this intelligence work well with others, are good at starting discussions or conversations, and are often labeled “the talkers” (McCoog, 2007, p. 27); however, Gardner (1999) warns not to stereotype this intelligence and think that all interpersonal students are extroverts. Suggestions for strengthening this intelligence include, having students work in cooperative groups,
participate in presentations, e-mail projects and videoconferencing (McCoog, 2007; Nolen, 2003).

**Intrapersonal intelligence.** Intrapersonal intelligence is the ability to know oneself and understand one’s inner workings (Nolen, 2003). Careers associated with this intelligence include CEO, clergy, entrepreneur, and psychologist (Shearer & Luzzo, 2009). Often students with this intelligence know how to plan effectively to achieve personal goals, understand and are in control of their emotions, and are reflective (Isisag, 2008; Shearer & Luzzo, 2009). Gardner (1999) also warns against stereotyping this intelligence and think that students that are strong with intrapersonal skills are all introverts. To strengthen this intelligence, work with students to complete long term projects, participate in self reflections, as well as give the students time to think (Isisag, 2008; Nolen, 2003).

**Naturalist intelligence.** The naturalist intelligence is having “expertise in the recognition and classification of the numerous species - the flora and fauna- of his or her environment” (Gardner, 1999, p. 48). Careers with this intelligence strength include biologist, farmer, meteorologist, and veterinarian (Shearer & Luzzo, 2009). These students prefer to be outside and enjoy working with rocks, water, sand, leaves or animals (Rettig, 2005). They tend to notice things in the environment that other people miss and have a heightened skill to categorize things from the natural world (Isisag, 2008). This intelligence can be strengthened by finding patterns and sorting natural objects, using cameras to record observations in nature, or care for a pet (McCoog, 2007; Nolen, 2003).
Existentialist intelligence. Gardner (1999) explained the existential intelligence as the “the capacity to locate oneself with respect to the furthest reaches of the cosmos… and the related capacity to locate oneself with respect to such existential features of the human condition such as the meaning of life” (p. 60). Professionals possessing this intelligence include religious leaders, philosophers, and web developers. Learners possessing the existentialist intelligence are very introspective; focusing on why the world operates the way it does and seeing the big picture (McCoog, 2007, 2010). These learners need time to ponder, conceptualize and hypothesize while they work to make connections between similar topics and incorporate aspects from other disciplines (McCoog, 2010). This intelligence can be cultivated by working with technology; such as a Web 2.0 project (McCoog, 2007).

Validity of Multiple Intelligences Theory

The validity of the MI theory is under attack when it comes to creating MI tests. Gardner (1999) explained it is difficult to create a short answer test for bodily-kinesthetic, spatial or musical intelligences. These intelligences should be tested using a performance test, not the traditional paper, pencil exam. Gardner (1999) also notes that most of the tests created for MI are more a measure of intelligence preferences, not the intelligence capacities.

In collaboration with David Feldman, Mara Krechevsky and others, Gardner (1999) developed a way of assessing intelligences by creating a “Spectrum classroom” (p. 136). The classroom was equipped with materials for children age four to seven to activate their different intelligences, including specimens of nature, board games,
artistic and musical materials, and areas for building, exercise, and dance (Gardner, 1999). Researchers observed that children found the materials inviting and interacted with them regularly. “The richness and sophistication” of the child’s interaction revealed the child’s “particular array of intelligences” (Gardner, 1999, p. 137). The “spectrum classroom” approach works to identify intelligences with older children by observing the student in uninterrupted exploration in a spectrum-like environment. Gardner (1999) warns that this is a snapshot of the child’s intelligence at this time and place and intelligences do change over time and with experience.

Waterhouse (2006) argues the validity of MI theory by use of its classroom applications. She states, “The successful application of MI theory in education practice cannot provide a test of the validity of the intelligences because the act of applying MI theory assumes the validity of the intelligences” (Waterhouse, 2006, p. 209). Gardner and Moran (2006) respond by explaining that MI theory is a work of synthesis and “it is repeatedly assessed and reformulated as new empirical findings from a variety of disciplines are analyzed and integrated” (Gardner & Moran, 2006, p. 230). Like many theories; such as plate tectonics, evolution, or MI theory, the theory develops as more evidence is accumulated, “which makes the theory more or less plausible, more or less relevant for further research, and more or less useful to practitioners” (Gardner & Moran, 2006, p. 230).

Waterhouse (2006) goes on to suggest that increases in academic achievement in a MI classroom “have been successful by serendipity” and the results could just as likely be due to teacher enthusiasm and student excitement for a new method (p. 209).
However, research repeatedly suggests the effectiveness of MI based teaching strategies on student academic improvement, and the empirical evidence that supports this is more than mere coincidence.

**Relevance of Multiple Intelligences Theory in Education**

The MI theory based teaching strategies have aided in student academic success in all levels of education and in several subject areas. A study conducted by Douglas et al. (2008) compared tests scores of eighth grade math students in a classroom utilizing MI teaching strategies and another using direct instruction. The posttest scores were substantially higher for students receiving instruction in the MI classroom compared to those students taught using direct instruction (Douglas et al., 2008). Researchers also noted that students who were in the MI classroom also had improvements in behavior (Douglas et al., 2008). They concluded that MI supports growth in several areas of importance to a student’s academic, social, and emotional well-being (Douglas et al., 2008).

In another classroom, MI based activities provided multiple approaches for students to gain knowledge and had a statistically significant effect on their academic success (Koksal & Yel, 2007). Researchers conducted a study on two tenth grade biology high school classes that were equivalent according to the students’ previous year grade points of achievement, intelligence fields, the number of students in the class, and pretest results. The experimental group received MI based instruction while the control group received traditional instructional methods, such as, question-response and direct instruction (Koksal & Yel, 2007). Results indicated that students
in the MI classroom had significantly higher posttest scores than those in the traditional classroom (Koksal & Yel, 2007). These results are due to the MI classroom providing multiple approaches for students to gain knowledge; therefore, having better connections to the content and resulting in better retention rates.

MI based instruction helps in math and science academic performance, as well as reading. In a recent study, middle school children participated in two different after school reading skills programs; one program was the traditional tutoring and the other program was MI style tutoring (Al-Balhan, 2006). The experimental group whose multiple intelligence was applied to learning, performed better in reading overall for the academic year than the students in the control group who studied using traditional teaching strategies (Al-Balhan, 2006). The researcher concluded that, “Multiple Intelligences empower children to be more successful” (Al-Balhan, 2006, p. 26).

Research supports that MI theory helps with learning in K-12 schools; as well as, higher education. Due to the increase in the number and diversity of students in higher education in many countries, there is a need for using MI theory in these classes to address the needs of all learners (Barrington, 2004). Just as in K-12 schools, higher education only focuses on mathematical and verbal-linguistic intelligences, which minimizes the importance of other forms of knowing (Barrington, 2004). These students with different forms of intelligence are held in low esteem and their strengths are unrealized (Barrington, 2004).

Barrington (2004) presented the MI theory in a workshop to a group of tertiary educators in hopes to inform them about the theory and its implications in the higher
education classroom. At the end of the four-day workshop, educators completed
surveys about the experience. The results of the surveys indicated that the educators
could see the “clear benefits for their students” (Barrington, 2004, p. 431). The survey
results also shed light as to why educators were not implementing the theory.
Educators felt they needed more ideas about how to incorporate MI into their teaching
or needed more time and resources to develop MI in the classroom (Barrington, 2004).

Sword (2007) experimented with her curriculum by incorporating MI theory
into her college level 20th-century poetry class. Instead of only focusing on the
linguistic intelligence by asking students to write an analysis of a poem, Sword (2007)
incorporated the visual intelligence by requiring students to create a visual
representation of a poem and justify the visual with an explanation. Sword (2007)
observed that “the assignment motivated [the students] to become more creative, more
daring, and more wide ranging in their thinking, and that creativity in turn infused
their literary analyses with energy and verve” (p. 232). Upon completion of the
project, Sword also noticed that “some of the most striking representations of the
poem were fashioned by students who had not otherwise distinguished themselves,
either in class discussions or in their previous writing, as highly motivated or
intellectually gifted” (p. 237). By incorporating MI theory into the classroom, more
students were able to show their understanding of the content and demonstrate their
intelligence.

MI theory helps with educational goals and is useful for career counselors
when giving career guidance. A study conducted by Shearer and Luzzo (2009) created
a MI inventory table that matched intelligences to corresponding career choices. For example, musical intelligence matched with songwriter and vocalist; logical mathematical intelligence matched with accountant and electrical engineer; and spatial intelligence matched with artist, architect, and pilot (Shearer & Luzzo, 2009). Shearer and Luzzo (2009) also created an inventory test called Multiple Intelligences Developmental Assessment Scale (MIDAS). The researchers argue that taking a student’s MI inventory (strengths and weaknesses) into consideration can greatly add to the career guidance conversation and provide more specific career opportunities rather than just a simple interest survey (Shearer & Luzzo, 2009). The use of MI theory also establishes a new way at understanding ways to be “smart” and expands the possible and realistic careers a counselee considers (Shearer & Luzzo, 2009, p. 6). They also believe that by using the MI language, they are able to communicate the necessary skills for careers or professions (Shearer & Luzzo, 2009).

The MI theory is applicable to educational systems throughout the world. In fact, Kornhaber (2004) reports that the MI theory has “been adopted and implemented for use in schools on six continents, from grade levels spanning pre-kindergarten through college, and for an enormous diversity of student populations” (p. 67). There is a widespread appeal of MI theory to education professionals which Kornhaber (2004) explains is due to MI theory validating what educators already know; people learn in a variety of ways. In addition, MI theory has been able to cross cultural boundaries because all eight of the intelligences “embody capabilities that are found in virtually all cultures” (Armstrong, 2009, p. 18). The fact that MI theory has been
implemented in so many countries and in all levels of education supports the relevance of the theory in the classroom.

**Incorporating Multiple Intelligences Theory into Curriculum**

Educational beliefs and practices are changing from previous generations because of MI theory; therefore, it is essential that teaching strategies reflect the changing viewpoints (Douglas et al., 2008). Creating innovative lesson plans that use the MI theory helps to meet the needs of diverse learners (Douglas et al., 2008).

MI theory works in conjunction with current teaching practices. The best advice is for teachers to use a broad range of teaching strategies and shift the intelligence emphasis from lesson to lesson (Stanford, 2003). For example, in the early childhood education realm, educators will likely find that they are already addressing several of the multiple intelligences through daily activities; such as, music (musical intelligence), movement activities (bodily-kinesthetic intelligence), teaching social skills (interpersonal intelligence), and language use (verbal-linguistic intelligence) (Rettig, 2005). Educators already use many other practices that fit with the theory, such as, learning centers, project-based learning, arts-integration, thematic units, and hands-on learning (Kornhaber, 2004). The MI theory can act as a framework for organizing and extend the educators’ practice into intelligences (Kornhaber, 2004). Educators can organize their curriculum by intelligence and evaluate what is missing.

Learning centers are an excellent way to incorporate and address the multiple intelligences. Learning centers involve several small groups of three to four children rotating through each of the centers every 15 to 20 minutes (Rettig, 2005). The centers
contain thematic units that encompass the multiple intelligences (Rettig, 2005). For example, in an early education classroom, a unit on fire safety could include activities such as:

- dramatic play/role playing firemen (intrapersonal and interpersonal), reading books about fireman (linguistic), drawing pictures of ladders (spatial), climbing ladders (bodily), demonstrating and talking about what fire looks like (naturalistic and linguistic), counting and identifying other things that are hot or learning to dial 911 (logical-mathematical), and finally singing songs related to stop, drop and roll (musical). (Rettig, 2005, p. 258)

By designing centers around multiple intelligences, all students will be able to have access to the curriculum and learn using their strengths.

To bring about the full benefit of MI theory for teaching and learning, assessment methods need to be changed as well (Stanford, 2003). MI theory provides an awareness of many assessment strategies that allow students to show they understand information and can use that information in new or unique ways. Assessment alternatives include logs and journals, graphic organizers, observational checklists, video samples, rubrics, and portfolios (Stanford, 2003). Such alternative forms of assessment offer students the chance to demonstrate learning in a variety of ways. These types of assessments also move beyond just measuring knowledge and skills and begin to measure the application or synthesis of knowledge and skills that will better meet the needs of learners (Stanford, 2003).
Differentiated Instruction

Description of Differentiated Instruction

Just like MI theory, DI is a belief that students learn in many different ways and instruction should mirror those differences (Anderson, 2007; Levy, 2008; Smith & Throne, 2009; Tomlinson, 2003). DI is not a new concept. The one-room schoolhouse is an example of teachers differentiating instruction to meet the needs of different aged students with different levels of readiness (Anderson, 2007; Smith & Throne, 2009). Teachers also differentiate instruction when they allow for more time on an assignment, allow student choice, or give different types of assessment (Levy, 2008). By its nature, “differentiation implies that the purpose of schools should be to maximize the capabilities of all students” (Anderson, 2007, p. 50). DI integrates learning styles, constructivist learning theory, and brain development with empirical research on influencing factors of learner readiness, interest, and intelligence preferences toward students’ motivation, engagement, and academic growth within schools (Tomlinson, 2003).

In education, fairness means that everyone receives what he or she needs, and not necessarily, that everyone receives the same instruction (Welch, 2000). However, the current climate of high-stakes testing has pressured teachers to deliver identical instructional activities to all students (Manning, Stanford, & Reeves, 2010). A generalized example of fairness is the use of glasses. One student needs glasses to see effectively, but asking all students to put on glasses because one student needs them is “foolish and a waste of time” and resources (Manning et al., 2010, p. 146). This idea
of fairness applies to students that need depth of instruction because they have already learned material but the teacher still requires the students to cover already mastered information or concepts. This indeed is not fair. DI creates fairness in education by meeting students at their level, varying the learning, and varying the assessments. Teachers who differentiate are incorporating best practices to aid in moving all of their students with different needs toward proficiency in the knowledge and skills established by state and local standards (Anderson, 2007). According to Manning et al. (2010), it is more important that each child receive the instruction he or she needs, not that all students are doing the same thing at the same time.

Researchers combined principles of DI with “socially mediated learning in peer groups” to assist in learning of academic content in inclusive eighth grade science classes (Mastropieri, Scruggs, Norland, Berkeley, McDuffie, Tornquist, & Connors, 2006, p. 132). Participants from 13 inclusive eighth grade science classes included 213 students, 44 classified with disabilities and 35 English language learners. Classes in the experimental group worked in groups of two or three to complete curriculum enhancements with three levels of differentiation based on readiness (low, middle, or high) that taught the “Scientific Investigation” unit of instruction (Mastropieri et al., 2006, p. 133). Classes assigned to the control group received traditional instruction that included teacher lecture, class notes, laboratory activities, and supplementary textbook materials (worksheets with fill-in-the-blank, matching, vocabulary, and short-answer items). Differences in posttest scores were statistically significant between the experimental and control class means (Mastropieri et al., 2006). High-
stakes test data approached, but did not attain statistical significance (Mastropieri et al., 2006). This investigation supports the effectiveness of using DI with peer partners in middle school inclusive science classes on content posttests and high-stakes testing (Mastropieri et al., 2006).

**Eight Elements of Differentiated Instruction**

Teachers who differentiate instruction believe that every child is unique, with differing learning intelligences and preferences (Anderson, 2007). DI provides the platform for providing individualized instruction for all learners in the general education classroom (Van Garderen & Whittaker, 2006). The core of DI is flexibility in content, process, product and learning environment based on student readiness, learning profile, interest, and affect (Levy, 2008; Tomlinson, 2003; Van Garderen & Whittaker, 2006).

**Readiness.** Tomlinson (2003) defines readiness as “a student’s knowledge, understanding, and skill related to a particular sequence of learning” (p. 3). Readiness is affected by cognitive proficiency, but even more influenced by prior knowledge, life experiences, attitudes about school, and habits of mind (Tomlinson, 2003). Grouping students by readiness is effective after the teacher has taught a lesson and then can group students based on their level of necessary support to continue in the learning (Levy, 2008). Groups should be based on assessment and never be stagnant (Levy, 2008).

**Learning profile.** Learning profile refers to how students learn best and is as varied as the personalities in the classroom (Levy, 2008; Tomlinson, 2003). Learning
style, intelligence preference, culture, and gender all shape students’ preferences for learning (Tomlinson, 2003). Teachers are aware that some students need to show you, some tell you, and some write it out (Levy, 2008). Grouping students by the same intelligence helps because they work to a common goal (Levy, 2008). Grouping students with different intelligences helps them support one another and learn from each other (Levy, 2008). If classrooms offer and support different modes of learning, it is likely that more students will learn more effectively and efficiently (Tomlinson, 2003).

**Interest.** Tomlinson (2003) defines interest as “those topics or pursuits that evoke curiosity and passion in a learner” (p. 3). Students already have interests in particular topics. Education offers the opportunity for students to discover new interests. Highly effective teachers attend to both developing and undiscovered interests in their students through DI (Tomlinson, 2003). Grouping students by interest allows them to develop their interests and learn from others (Levy, 2008). Students engage and persist in learning when their interests connect to school (Tomlinson, 2003).

**Affect.** Van Garderen and Whittaker (2006) define affect as the student linking of thought and feeling in the classroom. A teacher in a differentiated classroom considers student emotions and feelings (affect) in addition to student cognition (Tomlinson, 2003). Students tend to take cues from the teacher, so the teacher’s attitude about differences greatly influences how students treat difference (Broderick, Mehta-Parekh, & Reid, 2005). To support student affect, teachers need to model
respect, help students examine multiple perspectives on important issues, and ensure consistently equitable participation of every student (Van Garderen & Whittaker, 2006). Flexible grouping encourages students to build personal connections by working with different members of the classroom and avoids stagnant homogeneous groupings (Broderick et al., 2005).

**Content.** Content is what teachers teach and how students gain access to that knowledge (Levy, 2008; Tomlinson, 2003). DI allows for variation in content without lowering standards or expectations of students (Anderson, 2007). Teachers do not vary what they teach; rather they change how students encounter the information (Tomlinson, 2003). For example, a teacher might use visuals or graphic organizers, provide manipulatives, ask students to role-play, provide texts at various reading levels, or provide supplementary materials to enhance or support learning (Tomlinson, 2003; Van Garderen & Whittaker, 2006). Students may choose to work in pairs, small groups, or independently, but all are working toward proficiency on the same performance standards or curriculum objectives (Anderson, 2007).

There are times; however, when the variety of access to the same content is not enough. At those points, teachers need to vary the actual content (Tomlinson, 2003). For example, a student with serious cognitive challenges in an inclusive classroom may need separate curriculum some or all of the time (Tomlinson, 2003). If that student does not have a concept of numbers, it is inadequate simply to use manipulatives to teach multiplication (Tomlinson, 2003). The student’s current readiness to learn multiplication is so far from the learning goals that “it makes no
sense to try to teach him all of the same content at the same time and same pace as others in the class” (Tomlinson, 2003, p. 5). Similarly, a fifth grader who reads at a seventh grade level does not need the same reading skills lessons as his or her classmates (Tomlinson, 2003). The teacher will be more effective by varying what the student learns rather than simply how the student gains access to knowledge.

**Process.** Process includes how teachers teach and how students make sense of the information and skills in the lesson (Anderson, 2007; Levy, 2008; Tomlinson, 2003). Examples of process include class activities, labs, and homework (Tomlinson, 2003). These processes must address differing student readiness, learning styles, and interests (Levy, 2008). For example, a math unit may begin on problem-solving strategies with a mini lesson outlining the analysis of a problem. Students would be broken into smaller readiness groups and given problems appropriate for their level. Students would then be grouped based on intelligence (kinesthetic, linguistic, visual, etc.) to demonstrate distinct ways to solve problems and show how they came to a solution (Levy, 2008). Other ways to differentiate the process of a lesson include tiered independent work activities, cooperative grouping strategies, learning centers, and individualized homework enrichment projects (Anderson, 2007; Van Garderen & Whittaker, 2006).

**Product.** The product represents assessments or the way students demonstrate knowledge and skills attained because of learning (Anderson, 2007; Levy, 2008; Tomlinson, 2003). Effective products hold students accountable for using the foundational information, understandings, and skills of the learning (Anderson, 2007;
Summative assessments “can look as different from one another as our students do” (Levy, 2008, p. 163). Examples of summative examples include standardized tests, student portfolios, as well as teacher created tests, quizzes, projects or performance assessments (Levy, 2008; Tomlinson, 2003). Assessments should vary according to readiness, learning style, and interest, as well as allow for student choice using “choice boards” or open-ended lists of potential product options students can select (Anderson, 2007, p. 51; Levy, 2008).

**Learning environment.** Tomlinson (2003) describes the learning environment as the “weather” that affects virtually everything in the classroom (p. 5). Examples of learning environment include classroom rules and procedures, furniture arrangement, and availability of supplies and materials (Tomlinson, 2003; Van Garderen & Whittaker, 2006). Students should be able to choose the specific environment in which they prefer to work (e.g., near the board, in a quiet corner, on a rug) (Broderick et al., 2005). Another key factor is the “mood” of the classroom (Tomlinson, 2003, p. 5). The classroom should balance seriousness about work with celebration of success, contain evidence of respect for everyone, and everyone shares in responsibility for the operation of the classroom (Tomlinson, 2003).

**Universal Design for Learning**

**History of Universal Design for Learning**

In 1997, following the reauthorization of IDEA, principles of UDL developed (Edyburn, 2010). Stemming from an architectural viewpoint, Ron Mace stressed the importance of “a structure to accommodate the widest spectrum of users” (Rose &
Meyer, 2002, p. 70). Students of disabilities were gaining physical access to the general education classroom, but concerns were being raised whether the students were gaining access to the “general curriculum” (Edyburn, 2010, p. 34). The disparity between what is expected and how to achieve it was so great that, initially, the Center for Applied Special Technology (CAST) sought to “expand learning opportunities for individuals with disabilities” (Rose & Meyer, 2002, p. 2). After finding that the problem was not the learners, but instead, with a one-size-fits-all curriculum, educators began thinking of the curriculum as disabled, rather than the students (Edyburn, 2010). Educators were encouraged to see the range of learner differences, with varied abilities and qualities, and examine ways the “curriculum can be developed to include all learners from the outset” (Meo, 2008, p. 22).

In general education, UDL has created a solution for differentiating instruction by “identifying and removing barriers in the curriculum while building scaffolds, supports, and alternatives that meet the learning needs of a wide range of students” (Meo, 2008, p. 22). In the framework for creating this flexible curriculum, which in a standards-based setting includes instructional goals, methods, materials, and assessment, UDL uses innovative technologies to help accommodate learner differences (Meo, 2008). Using the UDL model, teachers are able to be flexible with what they teach and how to engage and assess the students. When the curriculum “is universally designed to enable all kinds of learners to access and progress in the curriculum, all students will benefit from having more flexible learning environments” (Meo, 2008, p. 22).
Seventy-two graduate and undergraduate students taking classes in education participated in a study that tested their ability to implement UDL concepts to students with disabilities (Spooner, Baker, Harris, Ahlgrim-Delzell, & Browder, 2007). Of the 72 students, 18% had never written a lesson plan, 87% were unfamiliar with UDL, and none of the students had written a lesson plan using the concepts of UDL (Spooner et al., 2007). The experimental group provided students with explicit examples of how to implement UDL concepts for students with disabilities, and then students developed a lesson plan that incorporated UDL. The control group received the same UDL instruction after the posttest. Researchers found that the one-hour UDL course enabled students to improve in developing lesson plans that successfully involved all students, including students with disabilities, before the lesson was presented, rather than modifying the lesson as an afterthought (Spooner et al., 2007). Training in UDL provides the lesson planning skills needed to design a universal curriculum for all students.

**Three Principles of Universal Design for Learning**

Students bring a variety of skills, needs, and interests to learning. Neuroscience reveals that these differences are as varied and unique as our DNA or fingerprints (“About UDL,” 2012). Three primary brain networks come into play when learning: recognition, strategic, and affective (“About UDL,” 2012). UDL provides a blueprint for creating instructional goals, methods, materials, and assessments that are flexible, adjustable, and customized to meet these individual needs (“About UDL,” 2012).
Recognition networks. On their website, CAST described this principle as how we gather facts and categorize what we see, hear, and read ("About UDL," 2012). To support this principle, educators need to focus on presenting information and content in multiple means of representation. Stockall, Dennis, and Miller (2012) explain multiple means of representation as ensuring that instruction, questions, and learning opportunities “exist in various formats and at different levels of complexity, addressing a range of ability levels and needs” (p. 12). Multiple means of representation provides options for perception, language, mathematical expressions, symbols, and comprehension ("About UDL," 2012).

Strategic networks. CAST describes this principle as how we organize and express our ideas ("About UDL," 2012). Educators need to differentiate the ways that students express what they know by providing multiple means of action and expression. Multiple means of action and expression is defined as ensuring that students “have a variety of formats for responding and demonstrating what they know, as well as a variety of formats for expressing ideas, feelings, and preferences” (Stockall et al., 2012). These formats can include options for physical action, expression, communication, and executive functions (overcoming impulse, set long-term goals, and monitor progress) ("About UDL," 2012). Educators should also consider providing a variety of materials for students to choose from, thereby addressing individual strengths, preferences, and abilities (Stockall et al., 2012).

Affective networks. This principle is the “why” of learning. According to CAST, affective networks are how learners engage and stay motivated by meeting
challenges, getting excited, or become interested in the content (“About UDL,” 2012). Multiple means of engagement means that various opportunities exist to arouse the attention, curiosity, and motivation of students by addressing a wide range of interests, preferences, and learning styles (Stockall et al., 2012). To maintain engagement and ensure successful learning, Stockall et al. (2012) suggests having different levels of scaffolding, repetition, and appropriate challenges. CAST suggests providing options for recruiting interest, sustaining effort and persistence, and self-regulation (“About UDL,” 2012).

**Summary**

NCLB Act legislation requires educators to show accountability by having students take standardized, high stakes tests. High stakes testing creates conflicts between what teachers believe is best practice and how to address testing pressures (Brimijoin, 2005). High stakes testing is pressuring teachers to deliver identical instructional activities to all students (Manning et al., 2010), even though teachers recognize that not all students learn the same way (Levy, 2008). We have to adjust our teaching style to reflect the needs of all our students.

The teaching standards created by districts and government make up the goals established for all of our students; however, how we reach these goals may require different paths (Levy, 2008). MI theory allows for multiple learning paths because it creates an environment, in which “participants can see, hear, and review information in different ways and can also reflect on the ways information is processed and learned” (Gardner, 2011, p. 100). Every learner has the potential to develop each of
the intelligences, and it is part of an educator’s job to nurture and help the children develop their own intelligences (Nolen, 2003). MI theory is an “inclusive pedagogy” because it takes a wide view of intelligence and works towards teaching and assessing students using more than just verbal-linguistic and logical-mathematical (Barrington, 2004, p. 432).

DI and UDL are two more teaching styles that aid in student achievement. DI is an approach to teaching and learning that involves careful analysis of learning goals, continual assessment of student needs, and instructional modifications in response to data about readiness levels, interests, learning profiles, and affects (Brimijoin, 2005). Teachers who differentiate use ongoing assessment data to inform instruction, increasing the likelihood those students engage with content, develop in-depth understandings, and build the capacity to transfer learning when the time for testing arrives (Brimijoin, 2005). UDL overlaps considerably with differentiated instruction, particularly with regard to material and instructional choice. The additional contributions of UDL are its emphasis on initial design considerations and digital technology (Van Garderen & Whittaker, 2006). Both strategies center lessons on the students’ needs (Van Garderen & Whittaker, 2006), which optimize learning for the whole class (Nolen, 2003).

The importance of attending to individual learning needs in America’s classrooms has reached a critical level as diversity multiplies across the student population (Brimijoin, 2005). MI theory, DI and UDL all focus on the diversity of students and allowing access to knowledge for everyone. Teachers need to consider
the cultural differences, gender, academic strengths, and weaknesses in students and work to reform the curriculum appropriately. Reforming the curriculum means reviewing lesson plans, texts, and supplements and figuring out different ways to teach the same information. This ensures that students receive a variety of teaching in their learning experience.

MI theory, DI and UDL are strategies that teachers can use to reform curriculum. MI theory allows students to learn using their best intelligence and express that knowledge in a comfortable format. DI recognizes what students already know and pushes them to learn more in a safe, respectful environment. UDL provides a framework for these diverse learners to access the curriculum by making the curriculum flexible. “Of the utmost importance to the teacher…is providing a learning environment and opportunities that exclude no child” (Anderson, 2007, p. 50). Truly, to leave no child behind, teachers need to design lessons using DI, the UDL framework, and incorporate MI theory in their classrooms, then students will have access to the curriculum and achievement will increase. The purpose of this project is to incorporate the theory of MI, DI and UDL into CA eighth grade science standards so that all students will be successful in the classroom and exhibit academic growth.
Chapter 3

METHODOLOGY

Introduction

This project makes use of the opportunity to create a curriculum for Science students in California. The first step in the development of this project was the review of literature, which covered current problems in Science education. In addition, an analysis of current instructional philosophies identified Multiple Intelligences Theory, Differentiated Instruction, and Universal Design for Learning as effective teaching theories. The purpose of this project is to combine MI, DI, and UDL, which creates a unique way for science teachers to help students efficiently develop a science skill base, have access to the curriculum, and succeed on standards based tests and assessments.

This project has been developed using the Science Content Standards for California Public Schools, Kindergarten through Grade Twelve. The unit is intended to be used by eighth grade Science teachers in California. The eighth grade standard for Earth in the Solar System states, “The structure and composition of the universe can be learned from studying stars and galaxies and their evolution” (California Department of Education, 1998, p. 36). As Plato once said, a reason to study astronomy is that “Astronomy compels the soul to look upwards and leads us from this world to another” (Brainy Quotes, 2013). Students will be able to gain an awareness of their environment on a cosmic level by participating in this unit.
Information on teaching strategies for this unit were gathered through research for the literature review, found in teaching journals, lesson plan websites, and teaching methods instructional books. Lesson ideas were adapted to fit the standards for eighth grade California Science classes. Having previously taught several of the lessons was valuable in understanding what aspect of the lessons worked for students and which areas needed improvement. Evaluation of all lessons ensured that the curriculum is engaging and exciting for teachers and students.

**Setting, Participants, and Instruments**

The setting and participants for this curriculum are eighth graders in California science classrooms. However, many state and national standards cover the same content; therefore, the curriculum is adaptable for those state standards to be used in elementary, middle school, or high school.

Students will need access to computers for portions of the lessons. Computers are necessary to conduct research. Students will also use the computers for computer processing programs such as Word and PowerPoint to complete assignments.

**Design**

The unit is comprised of 20 school days, including time for pre and post assessments, instruction, and project work time. The time for each lesson is 50 minutes. The goal of the unit is to meet the needs of all learners by incorporating multiple intelligences, differentiated instruction, and using universal design.

The astronomy unit includes pictorials, demonstrations, poetry, scale models, writing, graphing, sequencing, and drawing. Students will have the opportunity to
participate in differentiated lessons for multiple intelligences and accommodated for all learners. They will have access to technology while they conduct research and create PowerPoint presentations. Students will conduct labs to demonstrate the phases of the moon and relative distance of space objects. They will work individually, with partners, in small groups and participate in whole class discussions. By the end of the unit, students will be able to:

- Identify the shapes and names of different galaxies
- Compare and contrast stars based on size, temperature, and color
- Create a scale model of the solar system using astronomical units and light years as measures of distances between the Sun, stars, and Earth
- Explain how the Moon and planets shine by reflected sunlight
- Identify the appearance, general composition, relative position and size, and motion of objects in the solar system

Some of the essential skills will require more than one lesson in order for students to reach proficiency; therefore, those skills will have multiple days’ worth of instructional material. All lessons include student handouts, materials, assessments, and detailed lesson plan.

**Assessment**

Assessments vary in tasks and skills required, as well as being formative or summative. Using a variety of assessments allows all students to demonstrate what they have learned (Northwest Regional Educational Laboratory, 2005). Formative
assessments include class discussions, teacher observations of student discussions and participation, and probes (Keeley & Sneider, 2012). Class discussions are helpful assessments because they allow the teacher to hear what students are thinking and understanding about a topic. Not all students feel comfortable sharing their ideas with the whole class, so student discussions between partners are groups are essential to hear the thoughts of all students. The discussions and questions between students help them communicate and refine their understanding (Northwest Regional Educational Laboratory, 2005). Another strategy used to uncover student thinking are probes. Probes allow the teacher to measure one or two ideas that students have about a particular topic (Keeley & Sneider, 2012). When used as a pre-assessment, probes guide the teacher in lesson direction and depth. As a formative assessment, probes show if there was any growth in understanding and ability to justify an answer (Keeley & Sneider, 2012). All of the probes used in this unit are located in the Appendix.

Summative assessments include a multiple-choice pretest and posttest, Multiple Intelligence Assessment Menu (Lazear, 1994), and rubrics. The unit contains a multiple-choice pretest that is the same as the posttest to help direct the teacher in lesson direction, depth, and student grouping. The test will also prepare students for high-stakes style tests. A Multiple Intelligence Assessment Menu allows for student choice and multiple means of assessment (Lazear, 1994). The menu consists of a variety of assessments using several different multiple intelligences. Students choose and complete one or several assessments from this list to demonstrate their understanding of a particular topic. Rubrics are scoring tools that list the criteria for a
product or performance. Rubrics show gradations of quality for each criterion in a range from poor to excellent (Smith & Throne, 2009). All the summative assessments used in this unit are located in the Appendix.

**Implementation**

This curriculum is textbook independent and intended to supplement the coarse textbook. The activities engage all multiple intelligences to catch student attention and increase motivation. Use the activities as needed to strengthen the course curriculum. Teachers should pick and chose which lessons they think will best fit their students and timeframe.
Chapter 4

SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

Summary

Due to No Child Left Behind legislation, teachers have gone away from creative approaches for teaching and student centered learning to direct instruction to prepare students for high-stakes standardized testing. This one-size-fits-all curriculum is not supporting the increasingly diverse classrooms and changes need to occur to increase student engagement and achievement.

A review of literature found that MI, DI, and UDL are strategies that teachers can use to close the achievement gap for diverse students. MI theory “focuses on where the student is at;” however, MI takes that focus further since it covers a wider range of student learning styles (Barrington, 2004, p. 423). MI theory also supports the belief that students learn through activity, it is important to educate the whole child, all children have gifts, and all children should experience success in at least one area (Kornhaber, 2004). By incorporating MI theory in the classroom, students are encouraged to learn using their MI, which will allow them to “find personal meaning in their studies and their learning will be greatly enhanced” (Barrington, 2004, p 432).

DI is supported by constructivists “who argue that the best learning comes when students build their own mathematics, language skills, or science knowledge by arguing, challenging, explaining, solving problems, and having their own ideas examined by others” (George, 2005, p. 188; Smith & Throne, 2009). Effective differentiated classrooms have flexible groups where students can interact with a
variety of peers based on readiness, interest, or learning style and these groups are fluid and ever changing (Anderson, 2007; George, 2005).

UDL also focuses on learner-centered, constructivist curriculum (Curry et al., 2006). With the use of differentiated instruction and instructional technologies, all learners are able to “participate in the same rigorous, progressive, and thoughtful curriculum” (Curry et al., 2006, p. 33). UDL’s three core principles—representation, expression, and engagement—help educators to develop a motivating and accessible instruction that increases the participation of all learners (Spencer, 2011).

The purpose of this project is to use DI within the UDL framework to develop and provide MI integrated, ready to use lesson plans for teachers, administrators, and school districts to use in any California eighth grade science classroom, so that all learners can have access to the curriculum and achieve.

**Recommendations**

The methods outlined in the methodology can be adapted to teach any science standards at any grade level. The California eighth grade astronomy standards are similar to other state and national astronomy standards, so the lessons are easily adaptable to these similar standards. The unit planner and lesson plan outlines are useful for any content area or grade level.

It is important for teachers to take into consideration the strengths and weaknesses of all their students. Students need to feel safe in the classroom and be willing to celebrate differences. Teachers need to create flexible groupings based on ability, interests, learning profile. This curriculum allows teachers to differentiate their
lessons for multiple levels of preparedness, for multiple intelligences, and make accommodations to the curriculum for all learners. Activities in this unit engage students’ multiple intelligences, which in turn increases motivation. The unit utilizes a variety of assessments, both formative and summative, to help all learners demonstrate understanding. Teachers are encouraged to modify the lessons, activities, and assessments to meet the needs of their student population.

**Conclusions**

Student achievement is often quantified using tests scores. However, test scores are only a measure of limited forms of intelligence. There are many ways to learn, process, and remember a single concept (Gardner, 1983). Howard Gardner (1983, 1999) identified at least nine different ways of learning, known as Gardner’s Multiple Intelligences (MI) Theory. Gardner’s model offers insight into the nature of human learning potential, something not taught before to pre-service and in-service teachers though their job is to develop young minds (Campbell & Campbell, 1999). By teaching to all of the different intelligences, overall, there will be greater student success.

Integrating MI theory into classroom curriculum is effective in increasing student achievement for students of diverse backgrounds in a variety of school settings (Campbell & Campbell, 1999; Kornhaber, 2004; Ozdemir, Guneysu, & Tekkaya, 2006). This rise in achievement is likely due to curriculum being uncovered by incorporating MI theory, engaging students by using a variety of teaching tools, and students allowed to demonstrate learning using their best learning style (Kornhaber,
Moran, Kornhaber, and Gardner (2006) stressed however that MI does not mean that a teacher must teach eight or nine different lessons, one lesson for each intelligence. They stated that most people have “jagged profiles;” meaning they do not fit into just one intelligence (p. 23). Therefore, educators need to offer students a variety of rich experiences or activities in a lesson, so the students can engage in the material personally (Moran et al., 2006).

DI is an embedded teaching approach within UDL that advocates active planning for student differences in classrooms (Tomlinson, 2003; Van Garderen & Whittaker, 2006). Teachers will differentiate based on student readiness by varying the levels of difficulty of material or based on student learning preferences (i.e. intelligences, talents, learning styles) by allowing student choice (Anderson, 2007). When curriculum, instruction, and assessment is differentiated, all students within the mixed-ability, heterogeneous classroom are challenged and supported (George, 2005). This project allows for all students in the science classroom to have success.

Neil deGrasse Tyson, a world-renowned astrophysicist, eloquently described how humans’ knowledge of the universe, our study of science, ties us all together.

Recognize that the very molecules that make up your body, the atoms that construct the molecules, are traceable to the crucibles that were once the centers of high mass stars that exploded their chemically rich guts into the galaxy, enriching pristine gas clouds with the chemistry of life. So that we are all connected to each other biologically, to the earth chemically and to the rest of the universe atomically. That’s kinda cool! That makes me smile and I
actually feel quite large at the end of that. It’s not that we are better than the universe, we are part of the universe. We are in the universe and the universe is in us. (deGrasse Tyson, 2007).
APPENDIX

Astronomy Unit
Astronomy Unit

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<thead>
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<th>Astronomy Unit Planner</th>
<th>Subject Area: Physical Science</th>
<th>Unit Topic: Astronomy</th>
<th>Classroom Setting: GATE Education Class</th>
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<tr>
<td><strong>Essential Questions:</strong></td>
<td><strong>Unit Questions:</strong></td>
<td><strong>Core Concepts:</strong></td>
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<tr>
<td>1. Where are objects in relation to one another?</td>
<td>1. Where is Earth in relation to other universal objects?</td>
<td>1. Measuring in AU's and light years</td>
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<td>2. How are objects organized?</td>
<td>2. How is the universe organized?</td>
<td>2. Identifying elements</td>
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<td>4. What causes the phases of the moon?</td>
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<tr>
<th><strong>Unit Schedule:</strong></th>
<th><strong>Specific Student Characteristics:</strong></th>
<th><strong>Curricular and Instructional Strategies to Address Student Characteristics:</strong></th>
<th><strong>Link to Unit Schedule Number:</strong></th>
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<tbody>
<tr>
<td>1. Lesson #1 Astronomy Pre-Test</td>
<td>White male, age 13, LD classification, included in science, self-contained special education for other subjects, receives services of consultant teacher, entitled to adapted testing</td>
<td>Content: (Knowledge Construction; Technology) Guided notes Graphic organizers Online databases with a variety of reading levels Variety of solar system objects</td>
<td>2, 4, 7, 8, 9 2 - 10 7, 8 7</td>
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<td>2. Lesson #2 - Introduction to Astronomy</td>
<td>Afro-Hispanic female, age 14, returned to school after 3 months of home school instruction, below average in content knowledge and skills</td>
<td>Process: (Equity Pedagogy; Technology) Cooperatively structured groups Hands on concept lesson Scale diagram Groups choose solar system object and become experts Multiple Intelligence Centers</td>
<td>5, 9 4, 5, 8, 9 6 7 8, 9</td>
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<tr>
<td>3. Lesson #3 - Galaxy Classification and identification</td>
<td>Pilipino female, age 13, beginning ESL student, limited proficiency in English language, entitled to adaptive testing</td>
<td>Product: (Knowledge Construction; Technology) Galaxy Flip Book Classifying Stars Flip Book Multiple Intelligence Assessment Menu-Stars</td>
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<tr>
<td>4. Lesson #4 – Star classification and lifecycle</td>
<td>White male, age 12, 504 classified ADD, behavioral issues, academic skills deficient due to ADD</td>
<td>Spacing Out the Solar System-scale model</td>
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<td>5. Lesson #5 – Definitions and examples of rotation and revolution</td>
<td><strong>Whole Class Characteristics:</strong> (Consider: Readiness; Affect/Social Skills; Learning Profile; Interests; Gender; Race/Ethnicity; Culture; Language, Exceptionality).</td>
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<td>Going Through a Phase writing prompt</td>
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<td>Multiple Choice Unit Test</td>
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<td>6. Lesson #6 – Relating size and distances between planets</td>
<td>Class is dynamic and lively learning environment. Diversity of socioeconomic status from low to upper middle class. Student interests include sports, various genres of music, anima, and drawing. Ten percent receive special education services. Cultures and languages range from Chinese, Filipino, Latino, African-American, and American.</td>
<td><strong>Learning Environment:</strong> (Empowering School Culture; Technology) Classroom set of laptops, Classroom walls display content and inspirational posters, classroom walls display student work, active and successful recruitment of multicultural school board, administrators, teachers and staff</td>
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## Multiple Intelligence Matrix

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<th>Naturalistic</th>
<th>Bodily/Kinesthetic</th>
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</table>
Lesson 1:

Astronomy Unit Pre-Test

Basic Information

Subject: Physical Science
Grade Level: 8
Resources:
  - Astronomy Unit Test
  - Scantrons if available
Prior Knowledge: none
Time: One 50 minute class period

Standards and Objectives

Standard:

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   a. Students know galaxies are clusters of billions of stars and may have different shapes.
   b. Students know that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature, and color.
   c. Students know how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.
   d. Students know that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.
   e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

Objectives:

- Students will demonstrate knowledge and understanding of astronomy standards by taking a pre-test.
Performance Task and Assessment

Unit Questions:
1. Where is Earth in relation to other universal objects?
2. How is the universe organized?
3. How are stars, galaxies, and planets classified?
4. What causes the phases of the moon?

Procedures:
- Pass out Astronomy Unit Tests to each student. Explain that this is a pre-test, so the score will not count against the students grade, but will be used to determine the pace, grouping of students, and depth of lesson material that will be taught. (50 min)

Assessment:
- Formative assessment of the objective will be completed as the teacher monitors the students during testing.
- Summative assessment of the objective will be completed when the teacher grades the student pre-tests. This assessment will be used to determine the pace, grouping of student ability, and depth of lesson material taught in this unit.

Lesson Adaptations

Curriculum Extension:
- Additional questions, short answer, or essay questions can be added to the test.

Differentiated Instruction:
- Students will an IEP or 504 plan may need extra time, take the test in a small group setting, or have some of the multiple choice answers removed.
Lesson 1 page 3 of 10

Astronomy Unit Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. A __________ galaxy is shown in Figure 12.
   a. spiral
   b. elliptical
   c. barred
   d. irregular

2. The __________ would be the best unit to use for measuring the distance between the two galaxies shown in Figure 13.
   a. kilometers
   b. miles
   c. astronomical units
   d. light-years

3. A(n) __________ is a large cloud of gas, ice, and dust.
   a. nebula
   b. asteroid belt
   c. Oort cloud
   d. crater

4. Asteroids, the Sun, planets, comets, and other objects form the __________.
   a. atmosphere
   b. gravitational system
   c. solar system
   d. Earth system
Lesson 1 page 4 of 10

Name: _______________________

5. The largest planet in the solar system is _______.
   a. Venus                  c. Saturn
   b. Earth                  d. Jupiter

<table>
<thead>
<tr>
<th>Planet</th>
<th>Period of Rotation</th>
<th>Period of Revolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>59 days</td>
<td>88 days</td>
</tr>
<tr>
<td>Venus</td>
<td>243 days</td>
<td>225 days</td>
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<tr>
<td>Earth</td>
<td>24 hours</td>
<td>365 days</td>
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<tr>
<td>Mars</td>
<td>24 hours</td>
<td>687 days</td>
</tr>
</tbody>
</table>

Figure 1

6. According to the table in Figure 1, on which of the following planets is a day longer than a year?
   a. Earth                  c. Mercury
   b. Mars                   d. Venus

7. Smaller pieces of rock from old, broken-up comets become _______.
   a. comets                c. meteoroids
   b. meteorites            d. planetoids

8. ______ are pieces of rock that strike the surface of a moon or planet.
   a. Meteoroids            c. Meteor showers
   b. Comets                d. Meteorites

9. ______ is the third planet from the Sun.
   a. Mercury               c. Earth
   b. Venus                 d. Mars

10. One astronomical unit equals ______.
    a. the average distance from Earth to the Sun
    b. the amount of time it takes Earth to orbit the Sun
    c. the distance to the nearest star
    d. the amount of time it takes light to travel from the Sun to Earth

11. Which statement is true?
    a. Earth spins on its axis.
    b. The Moon spins on its axis
    c. Both Earth and the Moon revolve around the Sun.
    d. all of the above
Lesson 1 page 5 of 10

Name: ___________________________  ID: A

Distance of Outer Planets from the Sun

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<thead>
<tr>
<th></th>
<th>II</th>
<th>III</th>
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<tbody>
<tr>
<td>Jupiter</td>
<td>778,300,000</td>
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<tr>
<td>Saturn</td>
<td>1,427,000,000</td>
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<tr>
<td>Uranus</td>
<td>2,871,000,000</td>
<td>19.19</td>
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<tr>
<td>Neptune</td>
<td>4,497,000,000</td>
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<tr>
<td>Pluto</td>
<td>5,914,000,000</td>
<td>39.53</td>
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</table>

Figure 3

12. Some information is missing from the table in Figure 3. Which of the following would best to use as the heading for column II?
   a. Planets
   b. Distance in Kilometers
   c. Distance in Light Years
   d. Distance in Astronomical Units

13. The table in Figure 3 above compares two different ways of measuring distances in space. Which statement best describes the advantage of using astronomical units to measure these distances instead of kilometers?
   a. It is more convenient to use smaller numbers.
   b. It is more accurate to use kilometers.
   c. It is less scientific to use larger numbers.
   d. It is less confusing to use astronomical units.

14. The Sun is the center of the ______.
    a. solar system
    b. Milky Way
    c. constellation Ursa Major
    d. universe

15. Meteorites can be this type.
    a. irons
    b. stones
    c. stoney-irons
    d. all of the above

16. A comet is a(n) ______.
    a. small star
    b. large body of ice and rock
    c. chunk of rock and metal
    d. asteroid

17. Earth is part of the ______.
    a. Oort Cloud
    b. Milky Way
    c. Kuiper Belt
    d. asteroid belt
18. The diagram in Figure 5 shows the orbital paths of several bodies in the solar system. Which kind of solar system body has an orbit like that of the orbit labeled X?
   a. asteroid  c. moon
   b. comet      d. planet

19. About 90 percent of the stars in space are ___ stars.
   a. nebula  c. main sequence
   b. giant      d. white dwarf

20. The Sun produces energy by fusing hydrogen atoms into ___ atoms in its core.
   a. carbon  c. iron
   b. helium      d. oxygen

21. A galaxy that has a shape similar to a football is a(n) ___ galaxy.
   a. normal spiral  c. elliptical
   b. barred spiral      d. irregular

22. A ___ is a region so dense that nothing, including light, can escape its gravity field.
   a. supernova  c. black hole
   b. white dwarf      d. supergiant
Lesson 1 page 7 of 10

Name: ___________________________  ID: A

23. The sizes and colors of some stars are shown in Figure 2 above. Which of the stars shown represents the Sun in the current stage of its life cycle?
   a. 1  
   b. 2  
   c. 3  
   d. 4

24. A group of stars, gas, and dust held together by gravity is a ______.
   a. galaxy  
   b. constellation  
   c. Local Group  
   d. both a and b

25. A sequence of star colors from hottest to coolest is ______.
   a. blue, yellow, red  
   b. red, yellow, blue  
   c. blue, red, yellow  
   d. yellow, blue, red

26. A measure of the amount of light given off by a star is its ______.
   a. apparent magnitude  
   b. absolute magnitude  
   c. position in space  
   d. size

27. Figure 4 is a graphic organizer of stages in a star’s life cycle. Which stage in this diagram is incorrect, and what should this stage be?
   a. 1, Betelgeuse  
   b. 2, supergiant  
   c. 3, neutron star  
   d. 4, black dwarf
21. A measure of the amount of light received on Earth is a star's _____.
   a. apparent magnitude  c. position in space
   b. absolute magnitude  d. size

22. The Sun produces energy by forming ____ in its core.
   a. carbon  c. hydrogen
   b. helium  d. oxygen

23. Earth spins on its axis, and one rotation takes about one _____.
   a. hour  c. day
   b. week  d. year

24. The phase of the Moon that you cannot see is _____.
   a. Axons  c. full Moon
   b. new Moon  d. third quarter

25. The Sun was formed when energy caused by ____ in the center of the cloud of gas and dust radiated into space.
   a. nuclear fusion  c. gravity
   b. evaporation  d. none of the above

26. When the Moon and Sun are on opposite sides of Earth, a ____ Moon occurs.
   a. new  c. quarter
   b. gibbous  d. full

27. Earth's nearest neighboring planets are _____.
   a. Venus and Mars  c. Mercury and Venus
   b. Mars and Jupiter  d. Mercury and Jupiter

28. In Figure 2, the arrow going around the Sun indicates a planet's _____.
   a. attraction  c. rotation
   b. magnetism  d. revolution
## Answer Section

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### Astronomy Unit Test

#### Answer Section

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<td>8.4.b</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
<td>8.4.d</td>
</tr>
<tr>
<td>29</td>
<td>B</td>
<td>8.4.b</td>
</tr>
<tr>
<td>30</td>
<td>C</td>
<td>8.4.e</td>
</tr>
<tr>
<td>31</td>
<td>B</td>
<td>8.4.e</td>
</tr>
<tr>
<td>32</td>
<td>A</td>
<td>8.4.b</td>
</tr>
<tr>
<td>33</td>
<td>D</td>
<td>8.4.e</td>
</tr>
<tr>
<td>34</td>
<td>A</td>
<td>8.4.e</td>
</tr>
<tr>
<td>35</td>
<td>D</td>
<td>8.4.e</td>
</tr>
</tbody>
</table>
Lesson 2:

Introduction to Astronomy

Basic Information

Subject: Physical Science
Grade Level: 8
Resources:
- What am I student worksheet, answer key and PowerPoint slides
- How Big is Big student worksheet and answer key
- My Moon Calendar student worksheet
- Projector, screen, speakers and computer

Prior Knowledge:
- Science Vocabulary: planet, galaxy, star, moon
- Geography Vocabulary: hemisphere, continent, town, street

Time: One 50 minute class period

Standards and Objectives

Standard:
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution.

Objectives:
1. Students will identify different space objects.
2. Students will rank the sizes of geographic identifiers and space objects from themselves all the way to the universe.

Performance Task and Assessment

Unit Question:
- How is the universe organized?
Lesson 2 page 2 of 25

Procedures:
- Pass out the What am I student worksheet. Tell students to write their best guess as to the name of each space object. Allow the PowerPoint to run automatically while also playing the embedded song. Go through the PowerPoint a second time, slide by slide, without the music, to review the answers and elaborate on self selected slides. (25 min.)
- Pass out the How Big is Big student worksheet. Define any terms that students may not understand. Allow students to work individually to rank the size of items from self to universe. Next, have students share their answers with a partner. Finally, review the ranking with the class. (15 min.)
- Pass out My Moon Calendar to students. Explain that the students will be observing the moon’s shape every day for the next two weeks. Students will be completing this activity as homework and use it in a later lesson. (10 min.)

Assessment:
- Formative assessment of lesson objectives will be completed by teacher during class discussion and while he or she talks with students throughout the class time.
- Summative assessment of objectives 1 and 2 will be done when the teacher evaluates the completed student worksheets.

Lesson Adaptations

Curriculum Extension:
- If students have an overwhelming amount of questions about astronomy, the teacher can create a question jar or parking lot for these questions, and answer them when appropriate, throughout the unit.

Differentiated Instruction:
- Extra time may be needed to review the What am I PowerPoint based on student interest.
- Students who have IEP or 504 plans may be given a printout of the slides before the presentation.
Lesson 2 page 3 of 25

What Am I?
If you are not sure, just take a guess!
Be as specific as possible.

1. ______________   13. ______________
2. ______________   14. ______________
3. ______________   15. ______________
4. ______________   16. ______________
5. ______________   17. ______________
6. ______________   18. ______________
7. ______________   19. ______________
8. ______________   20. ______________
9. ______________   21. ______________
10. ______________  22. ______________
11. ______________  23. ______________
12. ______________  24. ______________
Slide 1

What am I?
Adapted from
Music by, John Williams

Slide 2

NASA/JPL
Slide 7

Is the hairdryer on or off? How can you tell?

Slide 8

Is the hairdryer on or off? How can you tell?
What Am I?
Teacher Key

Following are brief descriptions of each image. A website is given for most images if you (or your students) desire to do additional research about these objects. Nine of these objects are visible in (good quality) amateur telescopes (M57, M104, M20, M80, NGC 2392, M51, M42, and M87). Compare the telescopic view of one or more of these objects with the Hubble Telescope image. This will clearly demonstrate the value of a large telescope orbiting above Earth’s atmosphere. Music is Duel of Fates, by John Williams, The Phantom Menace Soundtrack

1 Saturn
The Cassini-Huygens spacecraft returned this image of Saturn on May 16, 2004. Enceladus, one of Saturn's 31 known moons, appears near the south-pole at the bottom of the image. Cassini was then about 20 million kilometers (12.4 million miles) away from Saturn. http://saturn.jpl.nasa.gov/multimedia/images/saturn/index.cfm

2 Ring Nebula, a planetary nebula
Located in the constellation Lyra, the Ring Nebula (M57) is the best-known example of a planetary nebula, the glowing remains of a doomed star. The Hubble telescope images reveal that the "Ring" is actually a cylinder of gas seen almost end-on. The Ring Nebula is about 2,000 light-years from Earth and has a diameter of about one light-year. The faint speck at its center was once a star of greater mass than our own Sun. Now, near the end of its life, it has ejected its outer layers into space, and the remnant is destined to die as a tiny white dwarf star, about the size of the Earth. Two centuries ago, astronomers studying these round-shaped objects through small telescopes called them "planetary nebulae," because their circular disks resemble those of planets. http://hubblesite.org/newscenter/newsdesk/archive/releases/1999/01/
Lesson 2 page 17 of 25

3 Sombrero Galaxy, a spiral galaxy
The Sombrero galaxy (M104) is an edge-on spiral galaxy in the constellation Virgo. It is about 28 million light-years away. The photo reveals a myriad of stars in a pancake-shaped disk as well as a glowing central bulge of stars.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2003/28/

4 Trifid Nebula
The Trifid Nebula (M20) is a huge cloud of gas and dust, illuminated by the light from nearby stars. Astronomers believe stars are forming within the nebula (a group of recently formed, massive, bright stars is easily visible in the image). Three huge intersecting dark lanes of interstellar dust make the Trifid Nebula one of the most recognizable and striking nebulae in the night sky. This nebula lies within our own Milky Way Galaxy about 9,000 light-years from Earth, in the constellation Sagittarius.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2004/17/

5 Globular Cluster
This stellar swarm is M80, one of the densest of the 147 known globular star clusters in the Milky Way Galaxy. Located about 28,000 light-years from Earth, M80 contains hundreds of thousands of stars, all held together by their mutual gravitational attraction. Especially obvious are the bright red giants, which are stars similar to the Sun in mass that are nearing the ends of their lives.
http://hubblesite.org/newscenter/newsdesk/archive/releases/1999/26/

6 Hair Dryer in infrared light
The infrared image shows the heat radiated by the hair dryer. Infrared is primarily heat radiation and is emitted by anything with a temperature - even objects that we think of as being cold. The scale shown to the right is the temperature in degrees Fahrenheit. For many more examples of infrared images and more information about the infrared, see:
7 Orion Nebula in visible (left) and infrared light (right)
The Orion nebula (M42) is a glowing cloud of gas and dust, about 1,500 light-years from Earth. The four brightest stars near the center are known as the Trapezium. (The Orion Nebula and the Trapezium are easily visible in amateur telescopes). Appearing like glistening precious stones surrounding a setting of sparkling diamonds, more than 300 fledgling stars and brown dwarfs surround the brightest, most massive stars in Hubble's view of the Trapezium cluster's central region. Infrared light can penetrate dust clouds better than visible light, giving astronomers a more detailed view of this stellar nursery.

What are brown dwarfs?
A Brown dwarf is a gaseous object, much larger than a planet, that has too low a mass for nuclear fusion to begin in its core.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2000/19/

8 Eskimo Nebula, a planetary nebula
This planetary nebula (NGC 2392), is an intricate structure of shells and streamers of gas around a dying sun-like star 5,000 light-years away. It is dubbed the "Eskimo Nebula" because, as seen through ground-based telescopes, it resembles a face inside a furry parka. (See object #2 on the previous page for more about planetary nebula)
http://hubblesite.org/newscenter/newsdesk/archive/releases/2000/07/

9 Earth
Few people have seen this view of Earth. This photograph was taken from the Apollo 12 spacecraft on Nov. 14, 1969 while on its way to the Moon.
http://images.jsc.nasa.gov/luceneweb/caption_direct.jsp?photoId=AS12-50-7362
Lesson 2 page 19 of 25

10 Whirlpool Galaxy, a spiral galaxy 0
The Whirlpool galaxy (M51) is a face on spiral galaxy in the constellation Canes Venatici. Numerous clusters of bright, young stars [highlighted in red] can be seen in the galaxy’s spiral arms. It is about 31 million light years away. The image is about 30,000 light years across in the horizontal direction.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/10/

11 Star Clusters 5
These two dazzling clusters of stars, called NGC 1850, are found in one of our neighboring galaxies, the Large Magellanic Cloud. (The Large Magellanic Cloud is not visible from Utah). The photo's centerpiece is a young, "globular-like" star cluster -- a type of object unknown in our own Milky Way Galaxy. The smaller second cluster is below and to the right of the main cluster. The stars are surrounded by diffuse gas [left], which scientists believe was created by the explosion of massive stars.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/25/

12 Constellation, Ursa Major
The brightest stars in Ursa Major form the asterism (star pattern) of the Big Dipper.

13 Galaxy Cluster
This is a massive cluster of galaxies called Abell 2218, which acts like a giant zoom lens in space. The gravitational field of the cluster bends and magnifies the light of more distant galaxies far behind it, producing the arcs of light seen in the image. The galaxy cluster is about 2 billion light years away in the constellation Draco.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2000/07/
14 Horsehead Nebula
The Horsehead nebula is a cold, dark cloud of gas and dust, silhouetted against a bright gas cloud, nebula IC 434. The bright area at the top left edge is a young star still embedded in its nursery of gas and dust, but radiation from this hot star is eroding the stellar nursery. The Horsehead nebula is about 1600 light years away in the constellation of Orion. The Horsehead nebula is visible in amateur telescopes, but it does require a large telescope and a very dark sky.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/12/

15 Jupiter and Io
This true-color image was taken on Dec. 12, 2000 by NASA's Cassini spacecraft. It shows Jupiter’s moon Io and Io’s shadow in against the disk of Jupiter. Io is one of Jupiter's four largest satellites, discovered by Galileo Galilei in 1610. An observer within Io’s shadow (the black circle), would experience a total solar eclipse.

16 Ant Nebula, a planetary nebula
The glowing remains of this dying, Sun-like star resemble the head and thorax of a garden variety ant. The star has expelled its outer layers to make the lobes of gas seen in this image. The so-called "ant nebula" is about 3000 light years away in the constellation Norma. It is about 1.6 light years long. (Norma is not easily seen from Utah.)
http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/05/

17 Microorganisms
Left - Cryptosporidium parvum oocysts. http://www.epa.gov/nerlcwww/cpt_seq1.htm
Right - Giardia lamblia cysts http://www.epa.gov/nerlcwww/gda_seq1.htm
Scale bar is 10 microns (micrometers).
18 Moon (from the side)
This color image of the Moon was taken by the Galileo spacecraft on Dec. 9, 1990, at a distance of about 350,000 miles. The near side of the Moon (the side always facing Earth) is to the right, the far side (the side always facing away from Earth) to the left. The concentric, circular Orientale basin, 600 miles across, is near the center. At the upper right is the large, dark Oceanus Procellarum; below it is the smaller Mare Humorum.
http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-moon.html

19 M87, an elliptical galaxy
Streaming out from the center of the galaxy M87 like a cosmic searchlight is one of nature's most amazing phenomena, a black-hole-powered jet of electrons and other sub-atomic particles traveling at nearly the speed of light. In this Hubble telescope image, the blue jet contrasts with the yellow glow from the combined light of billions of unseen stars and the yellow, point-like clusters of stars that make up this galaxy. Lying at the center of M87, the monstrous black hole has swallowed up matter equal to 2 billion times our Sun's mass. M87 is 50 million light-years from Earth in the constellation Virgo.
http://hubblesite.org/newscenter/newsdesk/archive/releases/2000/20/20

20 Solar Spectrum
This is light from the Sun spread out over all visible wavelengths. Elements present in the Sun’s atmosphere absorb particular wavelengths of the light, resulting in the dark lines. For a more detailed solar spectrum, and links to the spectra of two other stars, Procyon and Arcturus, see: http://www.noao.edu/image_gallery/html/im0600.html
Lesson 2 page 22 of 25

21 Venus transit of the Sun, 8 June 2004

A transit of the Sun is a passage of a planet across the face of the Sun. Observers on Earth can only witness solar transits of Mercury and Venus. Currently, transits of Venus occur in pairs eight years apart, separated by more than 100 years. The next Venus transit will occur in the year 2012, and then not again until 2117, and 2125. This image of Venus (dark circle near the bottom) passing in front of the Sun, was taken from the Swedish 1-m Solar Telescope (SST) in La Palma.


22 Comet

A comet is a small body that is part of the solar system. It has a solid nucleus (usually around 1-10 kilometers across) made mostly of ices, dust and rock. Many comets move in large elliptical orbits around the Sun. As a comet approaches the Sun, heat from the Sun causes the ices to vaporize, venting outwards from the nucleus, carrying along various atoms and molecules that make up the different ices, dust and rock in the comet. This creates a temporary (and extremely thin) atmosphere around the nucleus called the coma. Dust and gas pushed away from the coma by light and particles from the Sun forms the comet's tails.

This is a picture of Comet Halley, taken on March 8, 1986 by W. Liller from Easter Island, part of the International Halley Watch.

http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-comets.html

23 Waxing gibbous moon
How Big is Big?
Where Do You Fit Into the Universe?

Look at the word bank below. Beginning with the smallest circle as yourself, write the correct word or words in each circle. When you are done, you should have a graphic representation of your place in the universe.

WORD BANK:
me
town
state
continent
universe
local group
solar system
home
street
county
country
super cluster
galaxy
planet
hemisphere
How Big is Big?
Where Do You Fit Into the Universe?

Look at the word bank below. Beginning with the smallest circle as yourself, write the correct word or words in each circle. When you are done, you should have a graphic representation of your place in the universe.

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- me
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- state
- continent
- universe
- local group
- solar system
- home
- street
- county
- country
- hemisphere
- super cluster
- galaxy
- planet
- cluster of local groups

Universe
Super cluster
Local group
Galaxy
Solar system
Planet
Hemisphere
Continent
Country
State
County
Town
Street
Home
ME
Complete this calendar for the current month. Draw the moon’s shape every day for thirty days. Remember to look for the moon at night and during the day.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tr>
</tbody>
</table>
Lesson 3: Galaxy Classification and Identification

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:
- Set of student whiteboards, markers and erasers
- Document camera, projector and screen
- Galaxies reading guide
- Galaxies-Check for Understanding
- Galaxy Flip Book instructions
- Galaxy Examples

Prior Knowledge: none

Time: One 50 minute class period

Standards and Objectives

Standard:
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   a. Students know galaxies are clusters of billions of stars and may have different shapes.

Objectives:
1. Students will be able to classify galaxies as spiral, elliptical, or irregular shape.
2. Students will draw and give examples of each type of galaxy.

Performance Task and Assessment

Unit Questions:
- How are stars, galaxies and planets classified?
Lesson 3 page 2 of 7

Procedures:

- Pass out the reading Galaxies to all students. Read and discuss the sections with the class. Check for understanding of galaxy shapes by placing different pictures of galaxies, one at a time, under a document camera, and then have students identify the shape of the galaxy on whiteboards. (15 min.)
- Pass out plain white paper, Galaxy Flip Book Instruction sheets, and Examples of Galaxies color copies. Model the process to make a flip book with the students, and then explain and model the instructions for filling out the flip book. Students should be drawing, describing, and giving examples of each type of galaxy. (35 min.)

Assessment:

- Formative assessment of the lesson objectives will be completed by the teacher during class discussion through observation of student galaxy identification on whiteboards and student questions.
- Summative assessment of the lesson objective will be accomplished through evaluation of the completed Galaxy Flip Book.

Lesson Adaptations

Curriculum Extension:

- The content of this lesson can be extended to the history of discovery of different galaxies; specifically, the name of discoverer, name and date of discovery, and perhaps the location of discovery. Students could make a timeline of the dates of discovery.

Differentiated Instruction:

- Students who have IEP or 504 plans may be given a pre-made flipbook to complete.
Galaxies

Some of the fuzzy points of light in the sky that originally were thought to be stars are now known to be distant galaxies. Stars are not uniformly distributed through the universe but are unevenly clustered into groups. Massive systems of stars, dust, and gas held together by gravity are called galaxies. Gravity, the fundamental force responsible for the formation and motion of stars, also causes stars to group together into galaxies. Some galaxies contain billions of stars, all held together by gravity. Galaxies can have different sizes and different shapes. The most common shapes are spiral, elliptical, and irregular.

There are two types of spiral galaxies: regular and barred. Both types have arms that spiral outward, like pinwheels. Spiral galaxies have a nucleus, or central bulge, spiral arms, and a halo. Young, blue stars form in the spiral arms of a galaxy. The halo region of a spiral galaxy has little dust and gas, and contains mostly old star clusters. Viewed sideways, spiral galaxies are fairly flat except for the central bulge. You must see the galaxy from above or below to see the spiral arms. Some spiral galaxies contain a bar of stars, dust, and gas that passes through the center of the galaxy. These regions look like dark lines, or bars, so galaxies with these regions are called barred spirals.

Our home galaxy is called the Milky Way. It is a spiral galaxy. The Milky Way contains billions of stars, including our sun. All the stars we can see from Earth without a telescope are located in the Milky Way. The sun is located about midway from the center of the Milky Way galaxy, on one of the spiral arms. The bright band of stars cutting across the night sky is the Milky Way as seen from Earth.

Not all galaxies have spiral arms. Elliptical galaxies have an oval shape. They look like flattened balls. These galaxies contain billions of stars but have little gas and dust between the stars. Because of the lack of gas and dust, new stars cannot form in most elliptical galaxies. Most elliptical galaxies contain only old stars. Spiral galaxies tend to be more luminous than elliptical galaxies.

Some galaxies do not have regular shapes. Because of this, they are known as irregular galaxies. Irregular galaxies include all those that are neither elliptical nor spiral. They have a patchy appearance and are difficult to classify. The Large Magellanic Cloud is an irregular galaxy about 160,000 light-years away from our galaxy. It is one of the closest neighboring galaxies in the universe.

Adapted from K. Miyasaki
Galaxies- Check for Understanding

What shape is each of these galaxies?

Adapted from K. Miyasaki
Lesson 3 page 5 of 7

Galaxies Flip Book

Task:
You will describe galaxy shapes by creating a flip book that explains three major shapes of galaxies in words and pictures.

On the front cover of your flip book, write the name of each galaxy shape and draw a picture of each.

Inside the flip book, on the left, use the colored pictures to list examples of each type of galaxy.

Inside the flip book, on the right, write notes summarizing galaxy shapes. Your notes should be arranged so that when you lift the flip book cover for any galaxy shape, the notes beneath also describes that shape. Be sure to follow the rule of five – no more than five words at a time.

Galaxy Name
Picture

Shape 1
examples
Notes

Galaxy Name
Picture

Shape 2
examples
Notes

Galaxy Name
Picture

Shape 3
examples
Notes

Adapted from K. Miyasaki
Galaxy Examples

Great Barred Spiral Galaxy

M 86

Large Magellanic Cloud

NGC 6822

NGC 4911

NGC 4449

Adapted from K. Miyasaki
Lesson 3 page 7 of 7

Galaxy Examples

M 110

The Milky Way

NGC 4150

The Cigar Galaxy (M 82)

NGC 2903

NG 1316

Adapted from K. Miyasaki
Lesson 4: Star Classification and Lifecycle

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:

- Notice and Wonder: Stars
- Stars PowerPoint
- Classifying Stars Flip Book instructions and rubric
- The Lifecycle of a Star Notes
- Life of a Star Project
- 12 red, 12 yellow, 4 white, and 2 blue balloons (1 balloon per student for a class of 30)
- Wooden beads, marbles, ball bearings
- Markers for writing on balloons
- Pin (to pop balloons)

Preparation:

- Place 1 wooden bead inside each red and yellow balloon
- Place 1 marble inside each white balloon
- Place 1 ball bearing inside each blue balloon

Prior Knowledge:

- We live in the Milky Way Galaxy
- Elements Hydrogen and Helium
- Basic Knowledge of Atoms
- Gravity is an attractive force

Time: Four 50 minute class periods
Standards and Objectives

Standard:
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   b. Students know that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature, and color.
   c. Students know how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.
   d. Students know that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.

Objectives:
1. Students will identify and classify stars by size, temperature, and color.
2. Students will explain how stars create light.
3. Students will sequence the lifecycle of a low mass and high mass star.

Performance Task and Assessment

Unit Questions:
- How are stars, galaxies and planets classified?

Procedures:

Day 1
- Begin class by passing out a notice and wonder chart along with a HR diagram of stars. Ask the students to write down observations about the diagram in the notice section, and write questions in the wonder section. After a few minutes of students working alone, have students share their ideas with a partner, then share ideas with the class. Make a list of characteristics of stars; such as, size, shape, color, or temperature. (10 min)
Lesson 4 page 3 of 18

- Use the PowerPoint to introduce characteristics about stars; mass, color, and temperature. (15 min)
- Students will use the PowerPoint to make a flip book. Instruct the students how to make the book and fill it out to describe characteristics of stars. (25 min)

**Day 2**

- Review the previous day’s lesson by passing out balloons, distributing different colors, one balloon per student. You should have significantly more red and yellow balloons than blue and white, roughly 80% red and yellow, 15% white, and 5% blue. Explain that the property that causes the main differences between stars is mass. As you pass out balloons, tell students the approximate mass of their star, or have it written on the balloon. (5 min)
- Review which stars are the hottest stars (blue) and which the coolest stars (red) are. Ask what color our Sun is (yellow). (5 min)
- Using the PowerPoint and PowerPoint notes, to first teach how stars form through gravity’s force and nuclear fusion. Relate the temperature of stars to their mass. Also discuss that the distance of stars is related to time it takes for light to reach Earth, or light year. (15 min)
- Have students predict which stars live the longest and why. (5 min)
- Next, go through the lifecycle of stars. Use the balloons to sequence the stages, as well. When a star dies, pop or deflate the balloon to reveal the bead, marble, or ball bearing. (20 min)

**Day 3 and 4**

- Pass out the Lifecycle of a Star Menu. Explain to the students that they get to chose one of the options from the menu to complete. Briefly explain each option and what is expected for each. (10 min)
- Allow students to chose their project and give them two works days to finish the project. (90 min)
Assessment:

- Formative assessment of lesson objectives will be completed by the teacher as he or she asks discussion questions and talks with students while roaming the classroom. Assessment of objective 1 will be completed as the teacher evaluates the flip book students are creating. Objective 2 will be completed during the class discussion. Evaluation of the Lifecycle of a Star projects will be the assessment of objective 3.

- Summative assessment of objective 1 and 3 will be completed when the student flip books and projects are evaluated.

Lesson Adaptations

Curriculum Extension:

- The differences between nuclear fusion and fission can be discussed. Students can research the history of the hydrogen (fusion) bomb and the atomic (fission) bomb.

- Teachers may choose to have students share their projects with classmates.

Differentiated Instruction:

- Students may need more or less time for the flip book and Lifecycle of a Star project depending on the dynamics of the class.
Observe the HR diagram. Record your observations in the notice section of the chart. Record any questions you think of in the wonder section of the chart. Be ready to share your ideas with a partner.
Slide 1

The Life Cycle of Stars

Slide 2

What is a star?

- Stars are massive, glowing spheres of hot gases.
- Stars are mostly made of hydrogen and helium.
- Stars come in all sizes, brightness, temperatures and colors.
How bright is a star?

**Luminosity**
The larger a star is, the more energy it puts out and brighter it is.

**Brightness**
The closer a star is the brighter it appears.

---

**Apparent vs Absolute Magnitude**

**Apparent Magnitude**
The observed luminosity of a star as seen from Earth

**Absolute Magnitude**
The apparent magnitude of a star if it were 32.6 ly from Earth
Slide 5

How hot is a star?

- Water freezes = 0 ° Celsius (C)
- Hot summer day = 40 ° C
- Boiling water = 100° C
- A star = 3000-25,000° C

Slide 6

Temperature and Color

- Blue or bluish white are the hottest
- Yellow stars (like the sun) are medium temp
- Orange stars are the cooler

Colors are exaggerated
Slide 7

**Types of Stars**

<table>
<thead>
<tr>
<th>Star Type</th>
<th>Diameter (1 = Sun)</th>
<th>Mass (1 = Sun)</th>
<th>Surface Temperature (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supergiant</td>
<td>100 - 1,000</td>
<td>8 - 17</td>
<td>variable</td>
</tr>
<tr>
<td>Red Giant</td>
<td>10 - 100</td>
<td>1 - 4</td>
<td>3,000 - 4,000</td>
</tr>
<tr>
<td>Main Sequence</td>
<td>0.1 - 15</td>
<td>0.1 - 60</td>
<td>2,400 - 50,000</td>
</tr>
<tr>
<td>White Dwarf</td>
<td>0.01</td>
<td>0.5 - 144</td>
<td>100,000 - 6,000</td>
</tr>
<tr>
<td>Neutron Star</td>
<td>0.00</td>
<td>1 - 4</td>
<td>variable</td>
</tr>
</tbody>
</table>

Slide 8

**Hertzsprung-Russell Diagram**

- **Brighter**
- **Dimmer**
- **Hotter**
- **Cooler**
Slide 9

YES! Our Sun is a Star!
Why is it so much bigger?

• The difference is distance.
• The other stars we see are light years away.
• Our sun is only about 8 light minutes away.
• Sun is 1.4 million km across
• Can hold more than a million planets the size of the Earth.

Slide 10

How do stars shine?

• **Nuclear fusion** is the way that stars produce energy.
  – Reaction converts four hydrogen nuclei into the nucleus of a helium atom,
  – Releases a tremendous amount of energy.
Lesson 4 page 11 of 18

Slide 11

Life Cycle of a Star
Beginning

- Starts as a cloud of dust and gas that gradually presses together due to gravity - called a Nebula.

Slide 12

Life Cycle of a Star
Middle

- 90% of all stars are main sequence.
Life Cycle of a Star
End-Small Mass Star

• Stars become “old” when they use up all their fuel (Hydrogen)

• If it is a small-mass star, as it is dying it will blow up into a **RED Giant**

• then to a **planetary nebula**,

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Life Cycle of a Star
End-Small Mass Star

• then it will shrink to a **white dwarf**...

• where it will eventually run out of hydrogen, fade and be called a **black dwarf**
Life Cycle of a Star
End-High Mass Star

- If it is a high-mass star, as it dies it will have a major explosion and turn into a supergiant...

Slide 16

Life Cycle of a Star
End-High Mass Star

- Then it turns into a supernova...
- and then it condenses into a neutron star
- or a black hole!
Life Cycle of a Star
A comparison to us!

- Protostar
- Fusion ignition - Main Sequence
- Red Giant/Supergiant
- White Dwarf/Black Hole
- Fetus
- Infancy through Adulthood
- Middle Age
- Old Age-Death

Slide 18

Life Cycle of a Star
Bigger isn’t always better!

- Stars that have low or average mass, such as the sun, have long lives.
  - (10 billion years)

- High mass stars have short lives.
  - (1 million years)
Life Cycle of a Star
Let's Review

Low-Mass Stars-Main Sequence → Red Giant → Planetary Nebula → White Dwarf → Black Dwarf
Nebula

High-Mass Stars-Main Sequence → Supergiant → Supernova → Neutron Star → Black Hole
Lesson 4 page 16 of 18

**Classifying Stars Flip Book: Instructions**

**Task:**
You will describe characteristics of stars by creating a flip book that explains the three main characteristics (mass, temperature, and color) in words and pictures.

On the **front cover** of your flip book, draw a picture that explains each characteristic.

**Inside** the flip book, on the **left**, write a *one sentence* summary of the characteristic.

**Inside** the flip book, on the **right**, write a set of number notes to explain the three main characteristics of stars. Your number notes should be arranged so that when you lift the flip book cover for any characteristics, the notes beneath also describes it. Be sure to follow the rule of five – no more than five words at a time.

**Classifying Stars Flip Book: Rubric**

<table>
<thead>
<tr>
<th></th>
<th>Pictures</th>
<th>Description</th>
<th>Outlines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exceeds expectations</strong></td>
<td>Original pictures clearly show characteristics of stars. All pictures are accurate and show effort. Pictures are colorful.</td>
<td>One complete sentence that accurately and completely describes each characteristic of stars.</td>
<td>Each big idea has 4-5 details. Outline follows number note format. All details follow the rule of 5.</td>
</tr>
<tr>
<td>A or B work</td>
<td>4, 5 or 6 points</td>
<td>4, 5 or 6 points</td>
<td>8, 9, 10 or 11 points</td>
</tr>
<tr>
<td><strong>Meets expectations</strong></td>
<td>Pictures show characteristics of stars. Most pictures are accurate and show effort.</td>
<td>Sentence or mostly complete fragment that describes characteristics of stars. May omit an important detail.</td>
<td>Each big idea has 3 details. Most of outline follows number note format. Most details follow the rule of 5.</td>
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<tr>
<td>C work</td>
<td>3 points</td>
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<td>7 points</td>
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<tr>
<td><strong>Needs improvement</strong></td>
<td>Pictures do not show characteristics of stars. Pictures are inaccurate, and/or appear messy or rushed.</td>
<td>Does not have a sentence for each characteristic, or sentences do not describe characteristics of stars.</td>
<td>Each big idea has fewer than 3 details. Outline does not follow number note format. Few details follow the rule of 5.</td>
</tr>
<tr>
<td>D or F work</td>
<td>0, 1, or 2 points</td>
<td>0, 1, or 2 points</td>
<td>0, 2, 4, or 6 points</td>
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</tbody>
</table>
Lifecycle of a Star Notes

Complete the names and draw pictures for each step in the lifecycle of low-mass and high-mass stars.

Nebula

High-Mass Stars-Main Sequence

Low-Mass Stars-Main Sequence
THE LIFE OF A STAR!

Choose from the following list of activities to show your knowledge about the lifecycle of a star!

**Timeline:** Create an accurate timeline depicting the events that occur in the creation of a star. Include pictures and written descriptions. (Logical)

**Song:** Create a song or poem about the lifecycle of a star. It may be the tune from another song with the words replaced, or your very own creation. There should be at least 2 verses and a chorus for the song, or follow any format for your poem. (Musical)

**Interview:** With a partner, write and conduct an interview. One person is the interviewer and one is the “star”. The questions should ask about the lifecycle of a star. Questions and responses should be written on paper. (Interpersonal)

**Journal:** Write a journal of the lifecycle of a star. Describe life from the star’s perspective. Have at least 3 entries that are each a paragraph long. (Intrapersonal)

**Diorama:** Create a model of the lifecycle of a star. The model should be 3D and to scale as much as possible. Steps in the cycle should be labeled and briefly described. (Naturalistic)

**Dance:** Perform a dance about the lifecycle of a star. There must be a written reflection about how the dance relates to the life cycle of a star. There may be no more than 4 people in a group. (Bodily/Kinesthetic)

**Comic Strip:** Create a comic strip depicting and describing the lifecycle of a star. There should be at least 5 cells (boxes) and be colored or shaded. (Spatial)

**Newspaper Article:** Write a column about the lifecycle of a star. It can be an editorial, news report, an ad, etc. It must be at least a page long and be formatted for a newspaper. (Linguistic)
Lesson 5:
Definitions and Examples of Rotation and Revolution

Basic Information

Subject: Physical Science

Grade Level: 8

Resources:
- Spinning Round and Round student worksheet

Prior Knowledge:
- Be able to identify the Earth, Sun and Moon
- Gravity is an attractive force

Time: One 50 minute class period

Standards and Objectives

Standard:

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:

   e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

Objectives:

1. Students will be able to define rotation and revolution.

2. Students will act out the motions of rotation and revolution.

Performance Task and Assessment

Unit Questions:
- Where is Earth in relation to other universal objects?
Lesson 5 page 2 of 4

Procedures:

- Pass out the Spinning Round and Round student worksheet. Students begin by defining the terms rotation and revolution. Demonstrate the motions to the students using your body and/or an Earth, Sun, Moon model. Explain gravity’s role in keeping these objects in motion. (10 min)
- Group three students together and use a nametag to determine the Sun, Earth, and Moon. Demonstrate the motion of all three objects with one of the groups for the rest of the class. Go outside or into a multipurpose room so all the students can practice rotating and revolving like the Earth, Sun, and Moon. After a few minutes, have the students switch roles. (20 min)
- When students come back in, ask them to complete the close activity based on what they have learned. Review the answers with the class. (10 min)
- Have students complete the conclusion questions. Discuss the answers with the class. (10 min)

Assessment:

- Formative assessment of the objectives will be completed during the discussions and while observing the students rotating and revolving.
- Summative assessment of objectives 1 and 2 will be completed when the teacher evaluates the completed student worksheets.

Lesson Adaptations

Curriculum Extension:

- Students can model the motion of entire solar system, including all planets, selected moons, comets, meteors, and asteroids.
- Teachers can relate this lesson to day and night, seasons, and/or phases of the moon.

Differentiated Instruction:

- Teachers are encouraged to group students with mixed ability.
Define it! Using your textbook, define the following terms.

Revolution:

Rotation:

Describe it! Describe the motion of the Earth, Sun, and Moon.

Act it out! Work in groups of 3 to simulate the movement of the Earth, Sun and Moon. Your teacher will take you outside for this activity.

Apply it! Fill in the blanks in the following paragraph. Use the word bank to help you.

Revolve, rotate, 24, 365

All the planets _______________ around the sun. The Earth _______________ around the sun once every ____________ days. The Earth _______________ on its own axis every _______________ hours. The Moon _______________ around the Earth every 29.5 days and _______________ once on its axis every 29.5 days.
Reflect on it! Answer the following questions in full sentences.

1. Compare and Contrast the motion of the Earth and the Moon.

2. Why do we only see one side of the moon?

3. Do all planets revolve and rotate exactly the same as the Earth? Explain.
Lesson 6:
Relating Size and Distances between Planets

Basic Information
Subject: Physical Science
Grade Level: 8

Resources:
- Scale Model of the Sun, Earth, and Moon handout
- Size it Up student worksheet and answer key
- Spacing Out the System student worksheet and answer key
- Spacing Out the Solar System project instructions
- Calculators
- Art paper (at least 40 cm long)
- Signs with names of planets
- Meter stick, Ruler

Prior Knowledge:
- Measure using centimeters

Time: Three 50 minute class periods

Standards and Objectives

Standard:
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
c. Students know how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.
Lesson 6 page 2 of 13

Objectives:
1. Students will calculate the relative diameter and distance from the Sun for each planet.
2. Students will create a scale model of the relative distances of each planet from the Sun.

Performance Task and Assessment

Unit Questions:
- Where is the Earth in relation to other universal objects?

Procedures:

Day 1
- Students will be given a picture of the Sun, Earth, and moon in scale size to cut out. They will use these pictures to compare the relative sizes of the three objects. They will then move the pictures to the scale distance apart from each other and be asked reflection questions. Finally, they will be asked to predict the distance of the nearest star to this model. (10 min)
- Students will record the diameter of each planet. Then, they will calculate the relative diameter of each planet in comparison to Earth. After they have the relative diameters, they will graph these diameters to compare the sizes of the planets. (15 min)
- Students will record the distance of each planet from the Sun. Then, they will calculate the relative distance of each planet from the Sun in comparison to Earth. The Earth’s distance equals one astronomical unit (AU). After the students have the AU for each planet, they will convert these measurements for a scale model of the solar system. One model will be created outside using 1 AU equal to ½ meter. Use some type of sign for students to hold to or stick in the ground to mark the relative distance of each planet from the Sun. (25 min)
Day 2 and 3

- Students will refer to their relative distances in AU from yesterday. Today’s model will be created on paper, using 1 AU equal to 1 cm. Make sure the paper is at least 40 cm long. Students will use their notes and/or other resources to draw the relative distances of each planet from the Sun. (NOTE: the diameters of planets will not be to scale). Students will include the Asteroid belt and Kuiper belt in the drawing. (100 min)

Assessment:

- Formative assessment of the objectives will be completed by the teacher as she or he walks the classroom, talks with students, evaluates their progress, asks leading questions, and answers student questions.
- Summative assessment of the objectives will be accomplished when the teacher evaluates and grades the students’ final product of the scale distances of planets and the graphing activity from Day 1.

Lesson Adaptations

Curriculum Extension:

- Students could also include moons of different planets, comets, or other well-known solar system objects to their poster.

Differentiated Instruction:

- Students may need extra time to calculate the scale diameters, distances, or create the poster depending on the dynamics of the students or class.
SIZE IT UP

Relative Size of the Planets

<table>
<thead>
<tr>
<th>Planet</th>
<th>Diameter ÷</th>
<th>Earth’s Diameter = 12,756</th>
<th>Relative Diameter</th>
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Relative size can be determined by creating a ratio of the planets. By creating a ratio, you can obtain the relative size diameter for each planet in the solar system. Give the diameter of Earth a value of 1. You can then use that relative size to make your own solar system model by setting up a ratio for each of the planets. Complete the chart below for all the planets.
Graphing the Relative Size of the Planets

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Graph the diameters of the planets. Each space is equal to 5,000 kilometers.
## SIZE IT UP

### Answer Key

#### Relative Size of the Planets

<table>
<thead>
<tr>
<th>Planet</th>
<th>Diameter ÷</th>
<th>Earth’s Diameter =</th>
<th>Relative Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>4,880</td>
<td>12,756 =</td>
<td>0.38</td>
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<tr>
<td>Venus</td>
<td>12,104</td>
<td>12,756 =</td>
<td>0.95</td>
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<td>Earth</td>
<td>12,756</td>
<td>12,756 =</td>
<td>1</td>
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<tr>
<td>Mars</td>
<td>6,794</td>
<td>12,756 =</td>
<td>0.53</td>
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<td>Jupiter</td>
<td>142,984</td>
<td>12,756 =</td>
<td>11.21</td>
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<td>Saturn</td>
<td>120,536</td>
<td>12,756 =</td>
<td>9.45</td>
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<td>Uranus</td>
<td>51,118</td>
<td>12,756 =</td>
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<td>Neptune</td>
<td>49,532</td>
<td>12,756 =</td>
<td>3.88</td>
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</table>
# SIZE IT UP

Answer Key

Graphing the Relative Size of the Planets

<table>
<thead>
<tr>
<th>Size (km)</th>
<th>Mercury</th>
<th>Venus</th>
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*Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune*
In order to create a model of the solar system that is accurate in terms of distance, you use the astronomical unit, which is the average distance of Earth from the Sun, or 150,000,000 kilometers. The distance of the Earth from the Sun is then equal to one unit. By creating a ratio for each of the other planets, you can determine their relative distances. Complete the chart below and round your final answer to the nearest tenth.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Distance</th>
<th>150,000,000</th>
<th>Relative Distance</th>
<th>Rounded to Nearest Tenth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturn</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uranus</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neptune</td>
<td>÷</td>
<td>150,000,000 =</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Use the relative distances from the chart on the previous page to complete the chart below for creating a model solar system for the classroom and outside.

**Classroom:** Let Earth equal 1 centimeter

**Outside:** Let Earth equal 50 centimeters (0.5 meters)

<table>
<thead>
<tr>
<th>Planet</th>
<th>Classroom</th>
<th>Conversion to Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Venus</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Earth</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Mars</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Jupiter</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Saturn</td>
<td></td>
<td>× 50 cm</td>
</tr>
<tr>
<td>Uranus</td>
<td></td>
<td>× 50 cm</td>
</tr>
</tbody>
</table>

Use this information to construct both models of the solar system. Outside, have one student stand with a sign representing the Sun. Then, measure the appropriate distance from the Sun for each planet. Have a student stand with a sign of each planet to mark the relative distance from the Sun. Inside, use a paper to draw each of the planets from the Sun using the scale created in the chart.
SPACING OUT THE SYSTEM

Answer Key

Relative Distance of the Planets from the Sun

<table>
<thead>
<tr>
<th>Planet</th>
<th>Distance</th>
<th>150,000,000</th>
<th>Relative Distance</th>
<th>Rounded to Nearest Tenth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>57,900,000</td>
<td>150,000,000 =</td>
<td>0.386</td>
<td>0.4 AU</td>
</tr>
<tr>
<td>Venus</td>
<td>108,200,000</td>
<td>150,000,000 =</td>
<td>0.721</td>
<td>0.7 AU</td>
</tr>
<tr>
<td>Earth</td>
<td>149,600,000</td>
<td>150,000,000 =</td>
<td>0.997</td>
<td>1.0 AU</td>
</tr>
<tr>
<td>Mars</td>
<td>227,900,000</td>
<td>150,000,000 =</td>
<td>1.519</td>
<td>1.5 AU</td>
</tr>
<tr>
<td>Jupiter</td>
<td>778,400,000</td>
<td>150,000,000 =</td>
<td>5.188</td>
<td>5.2 AU</td>
</tr>
<tr>
<td>Saturn</td>
<td>1,400,000,000</td>
<td>150,000,000 =</td>
<td>9.51</td>
<td>9.5 AU</td>
</tr>
<tr>
<td>Uranus</td>
<td>2,870,000,000</td>
<td>150,000,000 =</td>
<td>19.14</td>
<td>19.2 AU</td>
</tr>
<tr>
<td>Neptune</td>
<td>4,500,000,000</td>
<td>150,000,000 =</td>
<td>29.98</td>
<td>30 AU</td>
</tr>
</tbody>
</table>
## SPACING OUT THE SYSTEM

### Answer Key

Scale Model of Relative Distance

<table>
<thead>
<tr>
<th>Planet</th>
<th>Classroom</th>
<th>Conversion to Outside</th>
<th>Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.4 cm</td>
<td>× 50 cm</td>
<td>= 20 cm</td>
</tr>
<tr>
<td>Venus</td>
<td>0.7 cm</td>
<td>× 50 cm</td>
<td>= 35 cm</td>
</tr>
<tr>
<td>Earth</td>
<td>1.0 cm</td>
<td>× 50 cm</td>
<td>= 50 cm</td>
</tr>
<tr>
<td>Mars</td>
<td>1.5 cm</td>
<td>× 50 cm</td>
<td>= 75 cm</td>
</tr>
<tr>
<td>Jupiter</td>
<td>5.2 cm</td>
<td>× 50 cm</td>
<td>= 260 cm</td>
</tr>
<tr>
<td>Saturn</td>
<td>9.5 cm</td>
<td>× 50 cm</td>
<td>= 475 cm</td>
</tr>
<tr>
<td>Uranus</td>
<td>19.2 cm</td>
<td>× 50 cm</td>
<td>= 955 cm</td>
</tr>
<tr>
<td>Neptune</td>
<td>30 cm</td>
<td>× 50 cm</td>
<td>= 1500 cm</td>
</tr>
</tbody>
</table>
Spacing Out the Solar System in Astronomical Units

Create a scale diagram of the solar system using your notes from class. Include the following features:

- **Title**---Spacing out the Solar System in Astronomical Units
- **Draw** a partial Sun on the far left of the page
- **Draw** each of the planets the **correct scaled distance** from the Sun
  - (Mercury, Venus, Mars, Earth, Jupiter, Saturn, Uranus, and Neptune)
- **Label** the planet **name and distance** from Sun in AU’s
- **Draw** the Asteroid Belt in between Mars and Jupiter
- **Draw** the Kuiper Belt after Neptune
- **Color** the planets, Sun, and belts the correct colors
- **Include** a **KEY** showing 1 cm = 1 AU

Project is due on ________________________________
Lesson 7:

Solar System Project

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:

- Projector, screen, computer
- Solar System survey
- Solar System Notes student worksheet and PowerPoint
- Solar System Project Reflection
- Research material; books, websites, magazines
- Solar System Project instructions (3 Tiers)
- Computer lab or laptops

Prior Knowledge: none

Time: Three and one half 50 minute class periods

Standards and Objectives

Standard:

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

Objectives:

- Students will be able to identify the appearance, general composition, relative position and size, and motion of several different objects in the solar system.
Performance Task and Assessment

Unit Questions:
1. Where is Earth in relation to other universal objects?
2. How is the universe organized?
3. How are stars, galaxies, and planets classified?

Procedures:

DAY 1 (half-day)
- The teacher will model a project that shares information about Earth. The PowerPoint presentation about Earth models the basic facts (appearance, general composition, relative position and size, motion, and 3 interesting facts) needed for the student presentations. Students will take notes using a graphic organizer while the teacher presents. (25 min)
- Students will an interest survey on which space object to research. The teacher will use this information to group students for the project. (5 min)

DAY 2 and 3
- As students enter the room, they will be instructed to new seats. Students will be partnered based on readiness level from a pre-test given the day before and/or at the beginning of the unit. Students will also be assigned a space object to research based on an interest survey completed earlier. (If students preferred to work alone, they can say so in the survey). (5 min)
- Students will be required to research a space object. Each level of readiness will have slightly different content to research. (90 min)
  - Not Yet Ready- Identify the appearance, general composition, relative position and size, and motion of a space object. Describe the features to someone to try and persuade them to visit that space object.
Lesson 7 page 3 of 16

- **Just Ready** - Compare the appearance, general composition, relative position and size and motion of a space object to another space object (such as Earth).

- **Ready to go** - Evaluate if humans could inhabit the space object based on the composition, relative position and size and motion of the object.

- At the station, there will be appropriate reading level materials specific to the students’ topic for research, such as, websites, books, and magazines.

- At the end of each work day, students will complete a ticket out the door describing the progress they have made on their project and the next steps necessary to complete. (5 min)

**DAY 4**

- Students display their project for other students to review. Students will use the same note sheet from Day 1 to take notes on other student projects. (50 min)

**Assessment:**

- Formative assessment of the objective will be completed by the teacher as she or he walks the classroom, talks with students, evaluates their progress, asks leading questions, and answers student questions.

- Summative assessment of the objective will be completed by evaluating the final product. Each level of readiness will have slightly different product requirements.

  - **Not Yet Ready** - Product presentation should include pictures and descriptions to persuade someone to visit that space object

  - **Just Ready** - Product presentation should include pictures, descriptions and a diagram or scale model comparison

  - **Ready to go** - Product presentation should include pictures, descriptions and an evaluation supported by evidence of whether or not humans can inhabit the object.
o Any level can choose from the following list to present their information to the class. PowerPoint, Children’s Book, Travel Brochure

Lesson Adaptations

Curriculum Extension:

* Students can research other solar system objects not included on the survey.

Differentiated Instruction:

* Teachers are encouraged to group students with mixed ability.
* Students can be required to present their project to the class, rather than have the students do a gallery walk.
* Students may need extra time to create and/or present the product depending on the dynamics of the students or class.
# Space Object Survey

Name ___________________________ Period __________

<table>
<thead>
<tr>
<th>Space Object</th>
<th>Top 3 Picks</th>
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<tr>
<td>Mercury</td>
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<td>Venus</td>
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<td>Uranus</td>
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<td>Neptune</td>
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<tr>
<td>The Moon</td>
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<tr>
<td>Europa</td>
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<tr>
<td>Io</td>
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<tr>
<td>Asteroid</td>
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<tr>
<td>Meteor</td>
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<tr>
<td>Comet</td>
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<tr>
<td>Other</td>
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</table>

Choose the top three space objects you would like to research in this unit.

1. first pick
2. second pick
3. third pick

I want to work (check one)
- With a partner
- Alone
- No preference
Tired of the same family vacation to the same places?! Then this time, take a trip to EARTH, the most interesting planet in the solar system!
DISTANCE

- Earth has an average distance of 1 AU or 150,000,000 km from the Sun.

TRAVEL

- Our rocket flies at top speeds from the sun, so it will only take a little over one-third of a year to get there!

\[
150,000,000 \text{ km} \div 50,000 \text{ km/hr} = 3,000 \text{ hours} \\
3,000 \text{ hours} \div 24 \text{ hours} = 125 \text{ days} \\
125 \text{ days} \div 365 \text{ days} = 0.34 \text{ years}
\]
TRAVEL
- On our way to Earth, we will pass by a few other space objects!
  - Mercury
  - Venus
  - Earth’s moon

LENGTH OF DAY (Rotation)
- Earth’s day is equal to 24 hours
- That means it takes 24 hours for it to travel once on its axis
LENGTH OF YEAR (Revolution)

- Earth’s year is equal to 365 days
- That means it takes 365 days for Earth to travel once around the Sun.

TEMPERATURES

- The Earth's temperatures range from -127 °F to 136 °F (-89 °C to 58 °C)
- The average temperature on Earth is 59 °F (15 °C).

**Interesting Fact:** Earth has a thin atmosphere (made of 77% Nitrogen, 21% oxygen, and trace amounts of carbon dioxide and water) that sustains life and protects us from the Sun's radiation and falling meteors.
Lesson 7 page 10 of 16

Slide 9

COMPOSITION

- Earth is made up of layers
  - Crust - Silicate Rock
  - Mantle - Silicate rock (rich in Iron and Magnesium)
  - Core - Iron and Nickel

**Interesting Fact:** Earth is the only planet in the solar system to have liquid water on the surface.

Slide 10

DIAMETER

- The diameter of Earth is 7,899 miles (12,713 km)

- **Interesting Fact:** Earth is the fifth largest planet in the solar system.
After we explore the amazing planet Earth, you can wave goodbye to the liquid water and life saving atmosphere that make Earth so special and unique!
## Solar System Notes

<table>
<thead>
<tr>
<th>Composition</th>
<th>Temperature</th>
<th>Diameter</th>
<th>Revolution</th>
<th>Rotation</th>
<th>Distance from Sun</th>
<th>Picture</th>
<th>Name of Object</th>
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</thead>
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</table>
Solar System Project Reflection

1. Which space object would you like to visit? Why?

2. In the future, do you think it will be possible to visit other space objects? Why or why not?

3. Are you interested in exploring space? Why or why not?

4. What was the most interesting thing about this project?

5. What was the most difficult part of the project?

6. What was the easiest part of the project?

7. In the future, how will you handle a project like this again?
Space Object Project - Tourism

Purpose:
You and your partner are members of a small company that specializes in tours that allow travelers to experience our solar system first hand. Your company provides trips to all areas of the solar system. Once a customer arrives at their destination they will travel around the object several times. This allows the tourist to have close contact with the object of their choice. This type of trip will educate the traveler about the object they choose to visit as well as the object's role in our solar system.

Product Format:
You may choose from the following list to present information about your space object to the public, in hopes to have them pay to go on one of your tours.

- PowerPoint, Children’s Book, Travel Brochure

Listed are items that need to be included in your product:
1. Space object’s name
2. Picture of object
3. Object’s distance from the sun
4. Time required to travel to object (spacecraft travels at 50,000 km/hour)
5. Length a day lasts on the object (Period of rotation)
6. Length a year would last on the object (Period of revolution)
7. Diameter of object
8. Temperatures of object
9. Composition of object (what is it made of)
10. Include at least three interesting facts about your object

We will have _____ work days in class. Products are due on __________________.
Space Object Project - Colonization

Purpose:
You and your partner are members of a NASA mission group that will be analyzing different space objects to see if humans could inhabit them. You have been assigned a specific space object and must research information about it to decide if the object has the necessary requirements for human life. You will be presenting this information to the public in hopes to educate them about our possible departure to this object.

Product Format:
You may choose from the following list to present information about your space object to the public, in hopes to educate them about the possible colonization of the object.

- PowerPoint, Children's Book, Travel Brochure

Listed are items that need to be researched and included in your product:
1. Space object’s name
2. Picture of object
3. Object’s distance from the sun
4. Time required to travel to object (spacecraft travels at 50,000 km/hour)
5. Length a day lasts on the object (Period of rotation)
6. Length a year would last on the object (Period of revolution)
7. Diameter of object
8. Temperatures of object
9. Composition of object (what is it made of)
10. Evaluate if humans can live on this object. Support your decision with evidence you have researched.

We will have ______ work days in class. Products are due on ______________________.
Lesson 7 page 16 of 16

Space Object Project - Educational

Purpose:
You and your partner are members of an educational outreach program designed to teach the public about the solar system. You have been assigned a space object and need to compare characteristics about the object to Earth, so that the kids have a better understanding about both. You hope that your product will inspire the public to want to learn more about the object and space in general.

Product Format:
You may choose from the following list to present information about your space object to the public, in hopes to educate them about the object in comparison to Earth.
- PowerPoint, Children’s Book, Travel Brochure

Listed are items that need to be researched and included in your product:
1. Space object’s name
2. Picture of object
3. Object’s distance from the sun
4. Time required to travel to object (spacecraft travels at 50,000 km/hour)
5. Length a day lasts on the object (Period of rotation)
6. Length a year would last on the object (Period of revolution)
7. Diameter of object
8. Temperatures of object
9. Composition of object (what is it made of)
10. Create some sort of diagram or scale model to compare your object to Earth. Discuss their similarities and differences.

We will have _______ work days in class. Products are due on ________________.
Lesson 8: Describing Comets, Meteors, and Asteroids

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:
- Comets, Meteors, and Asteroids PowerPoint
- Comets, Meteors, and Asteroids Notes
- Comets, Meteors, and Asteroids Centers instructions
- Triple Circle Diagram and answer key

Center Materials:
- Sticks, marshmallows, ribbon, lamp
- Lyrics and/or tune of “Twinkle, Twinkle, Little Star”
- Books, magazines, or articles about comets, meteors, and asteroids
- Index cards for game questions
- Sand, marble, ruler
- Glitter, glue, colored paper
- Pictures of comets, meteors, and asteroids

Prior Knowledge: none

Time: Two 50 minute class periods.

Standards and Objectives

Standard:
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.
Lesson 8 page 2 of 13

Objectives:
1. Students will compare and contrast comets, meteors, and asteroids.
2. Students will identify the composition of comets, meteors, and asteroids.

Performance Task and Assessment

Unit Questions: How is the universe organized?

Procedures:

Day 1
- Students will view a PowerPoint about comets, meteors, and asteroids. They will take notes as the teacher explains the differences and similarities of all three space objects. (20 min)
- Students will choose from a list of centers. Each center will focus on learning about comets, meteors and asteroids and will require a different multiple intelligence. Depending on interest and difficulty, students will spend 10 to 15 minutes at each center. (30 min)

Day 2
- Students will continue at centers spending 10 to 15 minutes at each center. (30 min)
- Students will complete a reflection about participating in centers. (5 min)
- Students will complete a triple circle diagram comparing and contrasting what they have learned about comets, meteors, and asteroids. (15 min)

Assessment:
- Formative assessment of the objectives will occur as the teacher monitors student work at each center. The teacher will ask questions during the presentation and center time to evaluate student understanding.
- Summative assessment of the objectives will occur at students turn in products from the centers. All objectives will also be evaluated by student completion of the triple circle diagram.
Lesson Adaptations

Curriculum Extension:

- Students can have student interviews about centers they visited to share their work with others and gain understanding of the centers they did not experience.

Differentiated Instruction:

- Students may be grouped ahead of time based on learning intelligence.
- Some students may require a buddy to travel from center to center.
- Students may travel freely from center to center or be required to remain at a center for a specific amount of time.
COMETS, METEORS AND ASTEROIDS…OH MY!

What is a Comet?

- Very small, irregularly shaped body of solid ice, carbon, iron and dust
- As gets closer to sun, ice changes to gas and forms a “tail”
- May be leftover material from formation of solar system.
Slide 3

**Parts of a Comet**

A. **Ion Tail**
   Forms only when near the Sun

B. **Coma**
   Atmosphere around nucleus created when gases and dust release from nucleus

C. **Dust Tail**
   Forms only when near the Sun

D. **Nucleus**
   Loosely packed lump of icy material

Slide 4

**Orbit of a Comet**

- Where is the tail of the comet pointing as it orbits the Sun?
  - Away from Sun

- What is the shape of the comet’s orbit?
  - Elliptical
Slide 5

What is the difference between a meteoroid, meteor, meteorite??

- Meteoroid: small piece of rock or metal moving through space, left over from a comet or asteroid collision.
- Meteor: a streak of light in the sky made as a meteoroid enters our atmosphere. (shooting star, falling star)
- Meteorite: a tiny fragment of meteoroid that makes it to the earth’s surface.

Slide 6

Composition of Meteor

- Made of rock, iron and nickel
- Some astronomers think meteorites come from a small planet that broke apart during the formation of the solar system
Impact Craters

- Earth is continually bombarded by meteoroids
- Most burn up in atmosphere
- 1,000 to 10,000 kg of meteoric material falls to Earth each day
- Large meteoroids can produce impact craters
  - Example: Barringer Crater in Arizona

What is an Asteroid?

- Rocky object, smaller than a planet, with no atmospheres.
- Made of rock and metal or both.
- Some have a lot of Carbon
- Range in size from diameter of 940 km to less than 1 km.
Asteroid Location

- Most of the solar system’s asteroids are found in between Mars and Jupiter.
- These asteroids are left over from the formation of the solar system.
- Elliptical orbit sometimes disturbed which causes asteroids to hit Earth.
Comets, Meteors and Asteroids Notes

<table>
<thead>
<tr>
<th>Comets</th>
<th>Meteors</th>
<th>Asteroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Details:</td>
<td>Details:</td>
<td>Details:</td>
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</tbody>
</table>
Comets, Meteors, and Asteroid Centers

Name________________________________ Class___________ Date____________

Bodily-Kinesthetic: Create a comet using sticks, marshmallows, and ribbons for comet tails. Once the comet is constructed, walk the comet in an elliptical orbit around the Sun (lamp), keeping the tail of the comet pointed away from the Sun.

Musical: Using the melody “Twinkle, Twinkle, Little Star,” compose a song about comets, meteors, and asteroids which contains the following facts:

- parts of the comet (Nucleus, Coma, and Tail),
- elliptical orbit;
- difference between meteor, meteorite, and meteoroid;
- location of asteroid belt and composition of comets, meteors and asteroids.

Linguistic: Read about comets, meteors, and asteroids from various books and write and answer questions about the reading. The questions must call on higher-level thinking skills.

Intrapersonal and Existential: Individually, write about how a person’s life might resemble a comet,
Comets, Meteors, and Asteroid Centers

Reflection:

1. Which centers did you visit?

2. Which was your favorite center? Least favorite? Why?

3. Why did you choose these centers?

4. Where are other centers you would have liked to visit? Why or why not?

Interpersonal: With a group, create a game show about comets, meteors, and asteroids that includes visuals and fact cards. Questions presented to the “contestants” must call on higher-level thinking skills.

Naturalist: Using pictures of comets, meteors, and asteroids categorize them by their similarities.

Logical-Mathematical: Using a marble, sand and ruler, test the effect of drop height on crater diameter. Record your data and analyze the results.

Visual-Spatial: Using glue and glitter make a comet on colored paper and correctly label all the parts. Nucleus,
Use the information you have learned about comets, meteors and asteroids to complete the triple circle diagram. Each outside circle should contain information unique to each space object. The areas of overlap are what two space object have in common. The center is what all three have in common.
Comets, Meteors and Asteroids

Comets:
- Have icy bodies
- Parts: Nucleus, Coma

Meteors:
- Made of iron and nickel
- Known as shooting stars
- Create impact craters

Asteroids:
- Found between Mars and Jupiter
- Some made of carbon

Elliptical orbits
Orbit the Sun in the solar system
Made of rock and metal
Hit Earth

Name_ KEY_ Class_ Date_
Lesson 9:

Explaining the Earth, Sun, Moon system

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:
- Going Through a Phase probe
- Completed My Moon Calendar (see Lesson 2 page 25)
- Notice and Wonder: The Moon’s Phases
- Phases of the Moon Note Sheet
- Moon Phases lab sheet
- Oreo Moon Phases instruction sheet
- Phrases with Phases song
- Moon Memory Instructions

Materials:
- Large poster paper, stickers
- Lamps, Moon Pops (Styrofoam ball inserted on pencil)
- 8 Oreo Cookies, plastic knife (for each pair of students)
- If possible, instrumental version of Ants Go Marching and music player
- Moon Memory cards (set of cards with pictures of phases of moon to match to names of phases)

Prior Knowledge:
- Students should have been recording observations of the Moon’s shape during the last month.

Time: Two and a half 50 minute class periods
Standards and Objectives

Standard:

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
  d. Students know that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.

Objectives:

1. Students will draw and identify the eight phases of the moon.
2. Students will explain the cause of the phases of the moon.

Performance Task and Assessment

Unit Questions:

- What causes the phases of the moon?

Procedures:

**Day 1 (half day)**

- Pass out the probe Going Through a Phase to all students. Students will read the prompt, mark the answer they agree with, and then explain why they agree with that answer. Have a poster with spaces for each option from the probe for students to record their response. Students will place a sticker or other marker next to the response they agree with most. This poster acts as a quick visual for the teacher to see the students’ ideas about the phases of the moon. (10 min)

- Have students get out the My Moon Calendar that they have been working on since the beginning of the unit. Students will complete the Notice and Wonder handout about their moon calendar. Next, students will share their observations and questions with a partner. Then, students will share their ideas with the class. A recorder will create a class list representing the Notice and Wonder worksheet. Students will add these new ideas to their list. (20 min)
Day 2
- Pass out the Phases of the Moon Note Sheet to students. Show the phases of the moon animation (http://www.sumanasinc.com/webcontent/animations/content/moonphase.htm) using a computer, projector and screen. Use the animation to demonstrate the positions of the Earth, Moon, and Sun for each of the phases of the moon. Students will complete their notes as the teacher goes through each phase of the Moon. (20 min)
- Pass out the Moon Phases lab sheet. Each group of four students will need a lamp and moon pop. Explain that the lamp represents the Sun, the student is the Earth, and the moon pop is the moon. Students will take turns holding the moon pop in between themselves and the lamp while moving slowly counterclockwise. Students should see the shadow of the “moon” change as the position from the “Sun” changes. Students will record their observations by drawing each major moon phases and labeling the name of each phase. (30 min)

Day 3
- Students will be participating in three stations to review the phases of the moon. Each station will take about thirteen minutes and have a group of four students; therefore it will be necessary to have duplicate stations for classes larger than twelve.
  - STATION ONE: Oreo Moon Phases
    - Students will use Oreo cookies to demonstrate the phases of the Moon. The cookie represents the shadowed part of the Moon and the cream represents the lit portion. (13 min)
  - STATION TWO: Phrases with Phases
    - Students will practice singing the song Phrases with Phases to the tune of The Ants Go Marching. If possible, have the instrumental version of the song for students to sing along. (13 min)
Lesson 9 page 4 of 14

- **STATION THREE: Moon Memory**
  - Students will play the game Memory by matching pictures of the phases of the Moon to the names of the phases. Students will follow the basic Memory rules and scoring. (13 min)

- Pass out the Going Through a Phase probe again as a post assessment. Have students read the prompt, circle the answer they agree with, and explain their reasoning. In the explanation, have students write if their thoughts have changed based on the lessons from the last two days. (11 min)

**Assessment:**

- Formative assessment of objectives 1 and 2 will come from the completion of the Going Through a Phase probe. The poster paper marking student responses with stickers acts as a visual for the teacher to quickly seeing student thinking. The teacher will also review the explanations students wrote regarding the probe. Formative assessment will also occur as the teacher creates a list of observations and questions of the moon calendar, conducts class discussion during the Phases of the Moon Note Sheet, and checking off completion of the Moon Phases lab demonstrations.

- Summative assessment of objectives 1 and 2 will be completed upon evaluation of the Moon Phases lab sheet and evaluation of the second probe.

**Lesson Adaptations**

**Curriculum Extension:**
- Students can continue to complete the moon calendar and label the phases of the moon.
- Students can write their own song to help remember the phases of the moon.

**Differentiated Instruction:**
- Students may need more guidance and modeling for conducting the Moon Phases lab to see each explicit phase of the moon.
Going Through a Phase

Mrs. Timmons asked her class to share their ideas about what causes the different phases of the Moon. This is what some of her students said:

Mona: The Moon lights up in different parts at different times of the month.

Jared: The phases of the Moon change according to the season of the year.

Sofia: Parts of the Moon reflect light depending on the position of the Earth in relation to the Sun and Moon.

Drew: The Earth casts a shadow that causes a monthly pattern in how much of the Moon we can see from Earth.

Trey: Different planets cast a shadow on the Moon as they revolve around the Sun.

Oofra: The shadow of the Sun blocks part of the Moon each night causing a pattern of different Moon phases.

Natasha: The clouds cover the parts of the Moon that we can't see.

Raj: The Moon grows a little bit bigger each day until it is full and then it gets smaller again. It repeats this cycle every month.

Which student do you agree with and why? Explain your thinking.

Lesson 9 page 6 of 14

Notice and Wonder
The Moon’s Phases

Name____________________________________Class_________Date___________

Refer to your My Moon Calendar while completing this worksheet. Write down things you notice about the moon’s shape as the days pass. Look for any patterns and record your observations in the notice section. Think of questions about the moon, the shape and patterns. Record these questions in the wonder section of the worksheet. Write as many observations and questions you can think of.

<table>
<thead>
<tr>
<th>Notice</th>
<th>Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Phases of the Moon Note sheet

Name___________________________________Class__________Date___________

While observing the animated demonstration of the moon’s phases, record the name of each phase, draw the moon in the correct position around Earth, and draw the view of the moon from Earth.

(http://www.sumanasinc.com/webcontent/animations/content/moonphase.html)

View of Moon from Earth

View of Moon from Earth

View of Moon from Earth

View of Moon from Earth
**Moon Phases Lab**

Problem: To model the phases of the moon.

Materials: Moon Pop, Small Lamp

Directions:
1. Get a “moon pop” from your teacher.
2. The lamp represents the sun. You represent Earth.
3. Turn off the lights in the classroom. Turn on your small lamp.
4. Hold the “moon pop” in your left hand and face the sun.
5. Hold the moon so that it is between the Earth and the sun.
6. Notice that the side of the moon facing the Earth has no reflected light shining on it. This phase is called the NEW MOON.
7. Shade in a NEW MOON on the diagram.
8. Move the moon about 45° toward the left (counter-clockwise) around the sun.
9. Observe the sunlight reflected by the moon.
10. Shade this phase of the moon on the diagram.
11. Continue to move 45° toward the left (counter-clockwise) and record each phase of the moon.

Label each phase on the diagram: New moon, Full moon, Waxing crescent, Waning crescent, Waxing gibbous, Waning gibbous, First quarter and Last quarter.
Procedure:
1. Each pair of students will receive only 8 Oreo cookies.
2. Separate your cookies carefully, so that \( \frac{1}{2} \) of the cookie has **ALL** of the frosting and the other \( \frac{1}{2} \) of the cookie has **NO** frosting.
3. Use your plastic butter knife to scrape off the frosting from the first cookie, making a shape of the waxing crescent.
4. You will continue using the butter knife to scrape off the frosting for each of the moon phases. (How will you represent new moon?)
5. Place the cookies in order on a paper plate and label them correctly.

Questions: Please use complete sentences and restate once you have completed the lab.

1. Describe the process that causes the moon to appear as these different phases.
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

2. How long is one cycle of phases?
__________________________________________________________________
__________________________________________________________________

3. What is the average time (in days) between phases?
__________________________________________________________________
Diagram
After you complete the lab, draw and label each phase of the moon. Position 1 would be the new moon, ending with position 8 as the waning crescent.
Phrases with Phases

Lyrics by Becky Nelson, The Lunar and Planetary Institute
Sung to the tune The Ants Go Marching

Each Moon phase marches COUNTERCLOCKWISE —
Now, let’s start . . .
The FIRST PHASE is the NEW MOON that we see as DARK.
Then next the WAXING CRESCENT shines
A LITTLE LIGHT upon the RIGHT,
And after that’s the
QUARTER MOON, where the
RIGHT HALF’S LIGHT.

Following is WAXING GIBBOUS on the RIGHT,
Where the LIGHT continues SPREADING and becoming bright.
We’ll be HALFWAY through the phases soon,
With the FULLest, brightest, biggest MOON,
Just before the DARK creeps
On the RIGHT
Of a WANING MOON.
The WANING GIBBOUS phase is when the LIGHT will SHRINK,
Then what will be the next phase after that, you think?
It’s once AGAIN a QUARTER MOON,
But the DARK HALF’s now upon the RIGHT,
And the LEFT side is the
One’s that’s BRIGHT!!
Did you get that right?

The next phase is the LAST phase where there’s just a spark
Of light, so WANING CRESCENT appears ALMOST DARK!
The Moon is really magical,
When it’s WAXING, WANING, NEW OR FULL.
And it COULDN’T SHINE at all
WITHOUT……
THE SUN’S……..bright light!!

Moon Memory Instructions

1. Place all of the cards face down on the table.
2. Mix the cards up, then line the cards up in four rows of four.
3. The student with the longest hair goes first.
4. The student flips over two cards.
5. If the cards match (the same picture and name of a phase of the moon) the student removes the cards from the pile. The next student on the left takes a turn flipping over two cards.
6. If the cards do not match, the student turns both cards back face down. The next student on the left takes a turn flipping over two cards.
7. The student with the most matches wins!!
Lesson 10:

Astronomy Review

Basic Information

Subject: Physical Science
Grade Level: 8

Resources:

- Space Poem
- Art supplies (markers, colored pencils, crayons, etc.) for poem
- Sample Space Poem
- Space BINGO
- Tokens for Bingo sheet

Prior Knowledge: completion of astronomy unit

Time: One 50 minute class

Standards and Objectives

Standard:

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:
   a. Students know galaxies are clusters of billions of stars and may have different shapes.
   b. Students know that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature, and color.
   c. Students know how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.
   d. Students know that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.
   e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.
Lesson 10 page 2 of 7

Objectives:
1. Students will compare and contrast the size of space objects by creating a poem.
2. Students will review astronomy vocabulary.

Performance Task and Assessment

Unit Questions:
1. How is the universe organized?
2. How are stars, galaxies, and planets classified?

Procedures:
- Pass out the Space Object poem instructions. Students will be creating a poem about a space object. The poem will review the comparative size of the object to something larger and smaller and identify unique characteristics of the object. Students will also include a picture to represent their poem. (20 min)
- Pass out the Bingo sheets. Students fill in the Bingo sheet by placing one astronomy term in each box. The terms are listed at the bottom of the Bingo page. Student then match the terms to the correct definitions. During the game, the announcer only reads the definition of the word, while students find the correct word on the Bingo sheet. Play continues until someone gets five matches in a row and shouts, “Bingo!” Repeat the game for as long as time permits. (30 min)

Assessment:
- Formative assessment of objective 1 and 2 will occur as the teacher observes student progress on the space poem and completion of the Bingo definition sheet.
- Summative assessment of objective 1 will occur when the teacher evaluates the accuracy of the space poem for comparison of size and unique characteristics. Objective 2 will be assessed by reviewing the accuracy of the completed student definitions sheets.
Lesson Adaptations

Curriculum Extension:
- Students can conduct a gallery walk to see the work of peers and their poems.
- Students can present their work to the class in an oral presentation.

Differentiated Instruction:
- Showing an example of a poem to students helps students visualize the expected product.
- Different versions of Bingo can be played, such as four corners.
- The definition sheet can be out for students who need extra assistance or tucked away for a greater challenge.
Space Poems

Pick any space object we have learned about in this unit to write a poem about. Follow the format listed below for your poem. Include a visual for your poem using at least four colors.

**TITLE**: Name of object (centered)

**Line 1**: Brief (phrase) description
**Line 2**: Larger than....
**Line 3**: Smaller than....
**Line 4**: Giver of....
**Line 5**: Brief description repeated
EARTH

The BLUE planet
Larger than the MOON
Smaller than the SUN
Giver of LIFE
The BLUE planet
Lesson 10 page 6 of 7

Space BINGO

<table>
<thead>
<tr>
<th>Galaxy</th>
<th>Spiral</th>
<th>Astronomical Unit</th>
<th>Rotation</th>
<th>Craters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universe</td>
<td>Jupiter</td>
<td>Main Sequence</td>
<td>Yellow</td>
<td>Asteroid</td>
</tr>
<tr>
<td>Meteorite</td>
<td>Nebula</td>
<td>Blue</td>
<td>Solar System</td>
<td>Comet</td>
</tr>
<tr>
<td>Star</td>
<td>Helium</td>
<td>Apparent Magnitude</td>
<td>Black Hole</td>
<td>Saturn</td>
</tr>
<tr>
<td>Meteoroid</td>
<td>Revolve</td>
<td>Light-year</td>
<td>Planet</td>
<td></td>
</tr>
</tbody>
</table>
Lesson 10 page 7 of 7

**Space Bingo Definitions**

1. Everything that exists is part of this____________________________
2. The shape of the Milky Way Galaxy._______________________________
3. The brightness of stars as seen from Earth________________________
4. The distance used to measure the solar system_____________________
5. Round depressions on the moon’s surface._________________________
6. Massive system of stars, dust and gases held together by gravity. ______
7. This planet has the greatest mass.________________________________
8. Particles that hit Earth’s surface after producing a streak of light in the atmosphere.__________________________
9. A sphere of gas that produces light._______________________________
10. Asteroids, planets, comets, and meteors all orbiting the Sun make up this._____________________________________
11. A rocky object, smaller than a planet that orbits the Sun. ____________
12. This is the product of nuclear fusion. _____________________________
13. The highest temperature of stars is this color_______________________
14. Distance between galaxies is measured using this____________________
15. Huge cloud of gas and dust that will form a star____________________
16. A small, icy body with a highly elliptical orbit around the Sun__________
17. Any of the eight large heavenly bodies revolving about the sun and shining by reflected light._______________________________________
18. 90% of all stars are in this stage__________________________________
19. A region so dense that nothing can escape its gravity field.___________
20. Smaller pieces of comets that break off are called this.________________
21. Another term for planets orbiting the Sun.________________________
22. This planet has the most noticeable rings__________________________
23. The color of the Sun is this_______________________________________
24. Sunspots helped Galileo conclude that the sun makes this motion_________
Lesson 11:

Astronomy Unit Post-test

<table>
<thead>
<tr>
<th>Basic Information</th>
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<tbody>
<tr>
<td><strong>Subject:</strong> Physical Science</td>
</tr>
<tr>
<td><strong>Grade Level:</strong> 8</td>
</tr>
<tr>
<td><strong>Resources:</strong></td>
</tr>
<tr>
<td>● Astronomy Unit Test (see Lesson 1 pages 3 through 10)</td>
</tr>
<tr>
<td>● Scantrons if available</td>
</tr>
</tbody>
</table>

**Prior Knowledge:** completion of astronomy unit

**Time:** One 50 minute class period

<table>
<thead>
<tr>
<th>Standards and Objectives</th>
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</thead>
<tbody>
<tr>
<td><strong>Standard:</strong></td>
</tr>
</tbody>
</table>

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:

a. Students know galaxies are clusters of billions of stars and may have different shapes.

b. Students know that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature, and color.

c. Students know how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.

d. Students know that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.

e. Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

**Objectives:**

- Students will demonstrate knowledge and understanding of astronomy standards by taking a post-test.
Performance Task and Assessment

Unit Questions:
1. Where is Earth in relation to other universal objects?
2. How is the universe organized?
3. How are stars, galaxies, and planets classified?
4. What causes the phases of the moon?

Procedures:
- Pass out Astronomy Unit Tests to each student. Explain that this is a post-test of the unit, so the score will count on the student’s grade. (50 min)

Assessment:
- Formative assessment of the objective will be completed as the teacher monitors the students during testing.
- Summative assessment of the objective will be completed when the teacher grades the student post-tests. This assessment will be used to determine the student understanding of the objectives in the astronomy unit.

Lesson Adaptations

Curriculum Extension:
- Additional questions, short answer, or essay questions can be added to the test.

Differentiated Instruction:
- Students will an IEP or 504 plan may need extra time, take the test in a small group setting, or have some of the multiple choice answers removed.
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