EFFECTS OF CONSTRUCTIVIST APPROACH IN SCIENCE

A graduate project submitted in partial fulfillment of the requirements

For the degree of

Master of Arts in Education, Elementary Education

By

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Acknowledgments

I would like to acknowledge Dr. Susan Belgrad, Dr. Raymond Brie, and Joan Baca for supporting me throughout this academic endeavor.
Dedication

The work presented here is dedicated to my parents John Rhodes and Diane Chen, all those that contribute to inspiring young people to be productive members of society, and to all of my extraordinary students that will make a difference in the world in which we live.
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ABSTRACT

EFFECTS OF CONSTRUCTIVIST APPROACH IN SCIENCE

By

Aarika Rhodes

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Student achievement in science is becoming a major problem among students at all grade levels. In fact, the most recent U.S. science report card exposed that only 16 out of the 50 states have made small academic gains in science. What is more, students in both private and public schools are doing rather poorly in science at the elementary level. Studies have attributed these poor science performance to the use of traditional teaching methods, instead of the constructivists approach to teaching science causing a dramatic fall in student performance, while the science achievement gap increases between the United States and its rival countries. Research clearly indicates that constructivists approach leads to more successful outcomes, increasing student engagement, critical thinking skills, and even their overall desire to learn. The suggested curriculum project examines suggests the effectiveness of the constructivist approach to teaching science to students. It advances the argument of how the constructivist approach is more engaging, meets the Next Generation Science Standards (NGSS), California Common Core Standards and significantly increases students critically thinking skills. The sole objective for the curriculum proposal is to inspire an approach to learning science in a manner that is truly effective and more meaningful for students so they can make academic advances in science.
CHAPTER I: INTRODUCTION

The 2009 the National Center for Education Statics (NCES) science report clearly evidenced, that students in both private and public schools are doing rather poorly in science at the elementary level. The fact regarding U.S. student science performance cuts across gender and all ethnicities; American students are falling behind. Moreover, this insufficient foundation increases as they begin to move through the upper grades.

The 2009 PISA results placed U.S. students in the middle of the pack with Poland, France, and Portugal, well below students in Shanghai, Finland, Hong Kong and Canada in science education. In science achievement comparisons to other countries, students in the U.S. struggle with conceptual analysis, lack basic skills, lack motivation, or are already too far behind to catch up. This report gives us a glimpse of children not being prepared for high paying jobs, big companies being forced to look elsewhere to fill their positions, and compromising the overall future of the United States on both an innovative and economical level.

In the most recent Science Report Card, it is clear that student performance in science only improved in 16 out of the 50 states in the United States. This minimal 32% gain is unsatisfactory expressing that the latest teaching methods being used to improve science improvement was ineffective. Case in point, in 2009 eight graders scored 149 on the NRP and in 2011 only 16 states scored 151 out of 300. In 2009, 8th graders scored 149 on the NRP and in 2011 only 16 states scored 151 out of 300. In short, this research indicates that the other 34 states have either declined or flat lined when it comes to science, validating the concern that students at the middle school level still lack science proficiency. Furthermore, little has been done to increase student
achievement in science between 2009 and 2011. With students being unable to catch up, it is almost impossible for them to rise to a proficient level because they are too far behind.

Consequently, action needs to be taken to turn around the poor student achievement in science. The Next Generation Science Standards that have been adopted by many states have been developed to address these concerns. Therefore, the science curriculum proposal advanced in this project suggests the use of the constructivist teaching approach to promote high student achievement in science. The integrated constructivist methods integrated will underline students becoming able to acquire and apply science content knowledge to real-world scenarios, use academic language to qualify their reasoning when participating in meaningful projects, labs, and discussions, and equally important, display how students constructing their own knowledge, is not only more meaningful, but intellectually more beneficial. This project also places strong emphasis on student background or prior knowledge in order to create both a healthy and productive learning environment for all students. The project will also explore the role of the teacher, and the impact of constructivist teaching practices on inspiring students to construct their own knowledge in order to acquire and apply science content knowledge.

The Project

For the curriculum project to be effective, it is imperative that the NGSS Standards (2013), California Common Core Standards, and STEAM (Science, Technology, Engineering, Art, and Math) are the blueprint. The NGSS guides the instruction and content being taught, the California Common Core Standards help set the goals for the science unit to provide opportunities to integrate other core content areas, and STEAM allows for problem solving opportunities. All three work hand and hand to execute this science proposal.
CHAPTER TWO: LITERATURE REVIEW

Constructivism is a theory designed to elevate student learning and increase higher level thinking. This approach is aimed at maintaining student engagement by allowing them to construct their own meaning of various concept(s). It also pertains to enhancing not only a children's' academic ability, but their social awareness and emotional well-being. Constructivism emphasizes the importance of knowledge, beliefs and skills that an individual brings to the experience of learning (Garbett, 2011). The foundation of this method is rooted in the notion of students taking their knowledge and making real world connections. Its objective is for student learning to be personalized, have great depth, and increase a student’s desire to be engage in the content in which they are learning. The theory suggests that the more a child is encouraged to bring their personal-self to the content, the more he or she will get out of what is being taught.

According to constructivist theorists (Dewey 1897, 1963; Kolb 1984; Kolb and Kolb 2005; Piaget 1976), learning is a multifaceted process that involves the whole person and includes different states of thinking, feeling, behaving, and perceiving. Through this approach, students are highly encouraged to not just make discoveries in their reality, but construct and/or invent an understanding of reality in relation to pre-existing cognitive structures and expectations. An ideal constructivist learning environment enables learners to progressively develop deep understandings of domain knowledge through convenient access to appropriate and sufficient resources and extensive sharing of useful information (Kong, 2011; Richardson, 2003). Individuals may create new knowledge through their feelings, intuitions, implied meanings, and creative actions resulting from the event (concrete experience), or through engaging in theoretical interpretations and the development of representational schemas of the event; abstract conceptualization
(Naude, L. n., Bergh, T., & Kruger, I. (2014). In other words, through the constructivist approach, the content becomes more meaningful and purposeful which results in students learning to learn: not because they are instructed but because they are inspired to; the students are taking ownership over their own learning.

Teacher involvement is another essential part of the constructivist theory. Multiple studies have expressed that educators must invite students to experience the world’s richness, encourage them to ask questions and seek their own answers (Kim, 2005). Suffice it to say, this method depends on the way in which teachers formulate critical thinking and essential questions, engineers lessons, and how they connect a child’s personal experience to the concept(s) being taught. In a like manner, this method also depends on a teacher’s understanding that students do most of the talking, invent and explore their own ideas. The teacher must have patience that the ideas of children will grown in complexity as they eventually meet the instructional objective. Constructivist learning leads to self-learning where knowledge construction is the focus, where real-world problems are socially negotiated, and where thoughtful reflection on experience is emphasized (Petit, 2002). This can only unfold through the implementation of a teacher.

The constructivist method is a respected method that has been proven to improve academic achievement in all content areas. It is highly respected and encouraged by world-renowned theorists and educators. In conjunction with, it is a method that is currently being adapted by teachers world-wide to give students the opportunity to learn at elevated heights as well as connect their personal experiences to the different content areas.
**Benefits of Constructivism**

The constructivist approach helps improve student learning in science, mathematics, and literacy. Also, studies have shown that it elevates students’ comprehension levels (both fiction and nonfiction texts), their ability to apply knowledge, and critical thinking skills. Additionally, as constructivist methods unfold, students are immersed in an encouraging environment in which their teacher allows them to combine their personal experiences. Students preserve longer when problem solving, ask more meaningful questions, and become infused with a desire to keep learning.

Student participation is another asset of the constructivist approach. This type of instruction increases enjoyment in learning which has a direct impact on their overall understanding of most subjects. The more the students are engaged and personally invested in a lesson, the more they are likely to increase in their academic ability. Students who participate get to explore with less rigidness, provoking independent thought, creativity, and having a Socratic mindset. They are inspired to be in pursuit of discovering the concept(s) even if they are more challenging; thereby, less likely to give up or becoming discouraged.

Through the constructivist method, studies have also consistently shown that students will have greater opportunities to negotiate when they have a trusting relationship with their classroom teacher, which in fact is considered a key element in building a classroom learning environment (Davis, 2006; Davis & Cosenza, 1993; Davis, 2006; Turner et al., 1998; Turner et al., 2002). Those teachers who are in fact implementing the constructivist approach are putting their students in a position to not only qualify their reasoning, but rebut incorrect information with fact and reasoning. Equally important, is the development of critical thinking skills and creative
thinking. Interestingly, studies have continuously shown that teachers that have adapted the constructivist approach offer their students the platform to respectfully counter or argue ideas with both their teacher and fellow classmates which has proven to have a profound effect on their academic endeavors, self-esteem, and social skills.

**Constructivism Improves Science Learning**

Studies and findings show that the constructivist approach to science instruction improved classroom discourse, achievement in science, and even clarified misconceptions in science (Fensham, Gunstone & White, 1994; Shapiro, 1994; Tobin, 1993). Those students who are excelling in science, have the freedom to investigate, build their own understanding of complex topics, and navigate their way through information in a manner that advances their academic achievement. They are also are given the opportunity to scientifically decipher what is relevant to their research and inquiries. In addition, the constructivist approach used in science classrooms shows evidence that when students are taking ownership over their own learning and are engaged in the learning process, they are thinking and performing at higher levels. Research has clearly stated, that students who perceived their learning environment in a more constructivist they recognized that knowledge is ever changing and that they have ample opportunity to think critically and adopt meaningful learning strategies (Gaudelli, 2002).

In science, new information leads to knowledge and discovery; therefore, students must be guided to learn in away that is congruent with the way in which the world actually works. If we want students to evolve as both learners and profound thinkers, it is beyond imperative that we inspire them to be in pursuit the acquisition of current knowledge through internet access that informs them of news discoveries, and information, and encourages them to become critical
thinkers and become decisive individuals. For students to develop this pursuit, they must have the academic freedom and support within that freedom. Initial learning goals are set by the instructor, but students have the chance to reflect learning that matches their individual interests (Driscoll, 2005; Johnson, 2000). Suffice to say, the more interested a student is in the subject in which they are learning, the more knowledge they will acquire the information being extended. Because science is a subject area that has the potential to captivate the minds of young people, it is even more vital that they get a chance to explore and unravel discoveries.

Teaching science effectively is dependent upon understanding the complex relationship between learners’ prior understanding, science content, teaching approaches, and pedagogical content knowledge (Garbett, 2011). The constructivist approach is a method that has endless possibilities to improve the quality of learning for young people; therefore, it should become more implemented by educators. Educators need to provide experiences which challenge the learners' current understanding in order to help them restructure their ideas. Innovations in science pedagogy such as conceptual change teaching strategies hold much promise for dealing with students’ alternative conceptions. According to Wandersee et al. (1994), these strategies are grounded in constructivism, contemporary philosophy of science (e.g., Kuhn, 1970), and conceptual change theory (Posner, Strike, Hewson, & Gertzog, 1982).

**Constructivist Approach Improves Math Learning**

Studies show, mathematics is one of the most feared subject areas among students of all grade levels. Not only does it provoke intimidation and uncertainty among today’s generation, but it has negatively conditioned young peoples’ minds to believe that it is unconquerable—increasing their continued lack of proficiency and anxiety. Piaget claimed that math is one of the
three kinds of knowledge that children acquire simply stated, he asserted that mathematical knowledge such as $2 + 2 = 4$ and $3 \times 4 = 12$ is constructed by each child by making new relationships out of previously created relationships (Ewing and Kamii 1996). Research has found that the use of the constructivist approach in math will help alleviate the fictitious belief by far too many U.S. students that math is too complex to learn by reversing this unneeded stereotype. As previously stated, the constructivist approach promotes student construction of their own knowledge providing them with the opportunity to properly invest in the concept(s). Studies have shown that when students can relate math fundamentals to the real world as they make true sense of its significance because they are using their prior knowledge to make meaningful connections.

As teaching approaches have evolved they shown clear digression from teacher-centered to the learner-centered tendency, and of course, the teaching could not be said complete without having mathematics and algebra as its integral part (Ilyas, 2013). In contingent to this information, it is important that a teacher’s curriculum and methods are tailored specifically for their students and the different types of learners. In math, students’ achievement increases when the students are encouraged to use manipulatives, inductive reasoning skills, and have an opportunity to apply both their prior and new knowledge. Suffice to say, if students are to reverse the achievement gap in math, proper methods must be advanced.

**Constructivism Improves Literacy**

The constructivist approach increases students’ literacy proficiency in many ways. One principle that has become firmly established in reading theory is that readers must make use of background knowledge in sentence processing (Stanovich, 1994). Tying this to the constructivist approach, constructivists encourage students to brings their background knowledge into learning
so they can make meaningful connections to the text. By allowing students who have prior knowledge and worldly experiences to construct and apply what they already know, research has shown that they are more likely to have greater comprehension. Moreover, it allows students to think more deeply as well as develop stronger writing skills.

Another way that constructivism strengthens literacy is that it improves student’s metacognition allowing them to think about their common knowledge from various perspectives. When an educator uses the constructivist approach when teaching literacy, a student’s desire to achieve dramatically increases when they are forced to compare and contrast their personal experiences to the text. Studies cite also proven that when students are given the opportunity to relate their own life experiences, and these are properly scaffolded, and encouraged they connect their common knowledge, to become successful.

According to researchers, it is unfair to expect students to understand something in its entirety if they have not personally experienced it; especially, pertaining to academic language and vocabulary aspects of literacy. Moreover, if they have not been exposed to particular vocabulary words or received visual aids for new topics, they will be unsuccessful in developing their reading skills; hence, the importance of students’ constructing their own knowledge with teacher assistance. Building vocabulary skills is easier when the teacher is having their students connect words and their meanings to their own personal experiences. Those connections are what help make things memorable. Students have to connect their prior knowledge to the text in which they are reading; especially, nonfiction. Otherwise, they will be unable to comprehend what it is they are reading and serve no purpose. Concepts have to build upon each other for students to learn. What is more, the concepts have to be relatable in some fashion.
The construction part of the constructivism approach is important in literacy because a child’s achievement depends on those personal connections preventing them from feeling discouraged simply because they were not exposed. Equally important, this finding was consistent among various studies conducted in regards to literacy. In fact, it was transparent that a child’s age, ethnicity, or gender wasn’t a factor. It was merely the way in which the child was guided by their teacher who used constructivism methods. Suffice to say, the constructivist approach improves student achievement in literacy.

**Constructivist Approach Improves Art Abilities**

A constructivist learning environment in an art classroom can be characterized by student choice which is essentially the essence of the constructivist approach. This is important to take note of because art classes help students make choices, create things that have personal meaning, use their prior knowledge, and communicate big ideas. Additionally, students are also given the opportunity to learn how to critique their peer’s work and revise their own. This level of exploration validates why students are engaged in art classes and produce meaningful work. Many will argue that the arts are an important component to a child’s education and overall development as well. Ertmer and Newby (1996) write that learners should be viewed as active learners who construct and process new information—not as empty, passive vessels waiting to be filled. Newby, Stepich, Lehman, and Russell (2006) explain the role of the changing learner, saying that "demands on the learner have increased substantially, where once it may have been sufficient to learn rote responses within given working environments, now the real world demands individuals use higher-order reasoning skills to solve complex problems" (p. 6).
A constructivist learning environment encourages active learning and higher order thinking; especially, in an art classroom. Being that self-esteem, creativity, and imagination is fostered through art curriculum and is founded on the constructivist approach (student’s constructing their own knowledge), sets great precedence as to why this method of teaching is beneficial for all learners. For example, in multicultural art lessons, conversations with peers who hold different views or understandings of the world stimulate the values or constructions of meaning that grant new perspectives of the world (Kincheloe, Slattery, & Steinberg, 2000). Through critical discussions about art, students are challenged to consider crucial human questions regarding cultural images of what is true, beautiful, and moral (Scherer, 1999) and to construct or re-construct their own understandings and values. It is important for students learn to be open to new information, as well as consider different perspectives. The constructivist method ensures that and it is shown through art classrooms repeatedly.
CHAPTER 3: RATIONAL/METHODS

This unit is tailored for a seventh grade science class that ranges in academic ability, race, parental support, and socioeconomic status. In order to prove the constructivist approach is the most effective way for students to learn science at the highest level possible, I have engineered an extremely detailed astronomy unit that meets the NGSS, common core, and ELA standards. Within this unit, STEAM, literacy, social studies, math, and the arts are heavily interweaved. Moreover, this unit provides my population of students each the opportunity to deepen their understanding of the astronomy concepts being presented by giving them access to building up their prior knowledge. Conjointly, physics concepts are also present to show the students how science concept(s) connect. As a result, each student is able to make meaningful real world connections. Plus, it will help drive purposeful conversations with their peers, consider different perspectives, refine their own viewpoints, and learn to learn versus learn to memorize.

The primary goals for my curriculum project is for students to grasp the complexity of scientific thought and the way in which it has evolved over time along with logic and evidenced-based reasoning pertaining to the medieval times. Essentially, the lesson recaps development of scientific method through examining the solar system. Particularly, it examines the work of Ptolemy and contrasts it with the work of Galileo’s. Each student, will assume the role of a scientist and engineer by analyzing, reasoning, exploring through the use of the constructivist approach. Each student will also be inspired to connect their personal experiences to make thoughtful decisions while still considering the viewpoints individuals had during the medieval times. Students will work in small groups to com-
municate intelligently about their position by using academic language, consider their peer’s perspectives, and expand their insight on how the conflict of religion and science affects the world in which we live.

The depth of this astronomy unit is built upon the notion that in science, students need the opportunity to investigate, problem solve, and reason. To see that examining other people's work is advantageous in both science and life. Otherwise, one’s intellectual capacity will be compromised, resulting in not meeting grade level expectations and/or becoming proficient. Throughout the unit, there are several hands on activities that force students to create and play with their imagination. In addition to, primary sources, video clips, and group projects are used to scaffold and encourage student led conversations. This is essential so students can not only see and understand the why behind the content be taught, but so they can personalize it so they are in fact connected to the science content. Again, the foundation of this unit to make it personal and meaningful for all students. Similarly, seek connections between what is being taught and how it might and/or relate to something else; hence, the significance of merging the other content areas.

Equally important, for this unit to also have depth and promote literacy, nonfiction texts will be used throughout to help deepen each students understanding. The literature is a tool to help drive both the instruction, lessons, and student led discussions. Coupled with helping students improve upon their reading and writing abilities to meet the common core and ELA standards. Students will also use the non-fiction texts in order to learn how to research, draw conclusions, compare and contrast for their astronomy debate which takes place at the end of the unit.
In this unit, technology will also be used to help execute some of the lessons. The technology used consists of the following: Mac computers, printers, I-pads, Youtube, and a projector. These forms of technology are used to help scaffold the students, provide visual-aids (which is extremely helpful for the ELL students), and further their understanding of the various concepts for this particular unit. Moreover, it puts the students in a position to explore so they can draw conclusions and answer the essential questions from each lesson. For example, can history help us better understand science? Can religion and science be one of the same? Students will construct their own definition and answers to these key questions.

The constructivist approach accommodates all learners equally for this unit. Accommodations are made for those students who are gifted and students who have areas in which they need to improve upon. To begin, it gives students the opportunity to bring in their own personal experiences to the learning environment which allows the content to be personal and more meaningful. By the same token, it encourages student participation which sharpens their communication skills meeting the ELA standards. Next, the constructivist approach is limitless. Students are able to expand their knowledge to great heights for they are constantly building upon the science objectives and essential questions. Each student is able to ask purposeful questions and pursue the answers to those questions through the guidance of their teacher. Third, students are at a great advantage because the constructivist approach inspires critical thinking skills while motivating students to exhaust all possibilities when it comes to science. Suffice to say, this improves
students comprehension regarding complex science concepts which is why the constructivist approach is essential to this unit.

To begin this unit, students will be introduced to the biographies of Ptolemy and Galileo. This will help demonstrate how two contrasting individuals thought, approached explaining the Earth’s position in the solar system, and made influential marks in the world of astronomy in very different ways. Upon introducing these two scientists, the unit will transition into the students understanding the world views during the medieval times. Students will be engage in various activities that help further their understanding, but in a manner that shows them unraveling the content versus the teacher. Students will have access to technology and any resources needed to help them with their understanding of the concept(s). Also, explore works of art to enhance the mindset of people during this time period. Once the students have been exposed to Ptolemy, Galileo, gain background knowledge of the medieval times, and the evolution of scientific evidence, they will then begin to compare and contrast the view points each scientist had on the Earth’s position in the universe. They will begin to braid the history aspects and the NGSS standards together displaying their overall understanding; the big picture of the unit. However, students will be guided to link the knowledge they are acquiring to the real world. This section of the unit demands that the students are critically thinking, discussing and analyzing their results from their experiments and activities, and challenge one another in a respectful way. In short, they are learning how both their successes and failure can be their best advancements; especially, in the world of physics.

The student population for this project is designed and differentiated to meet the needs of all students. The students will work in and out of the classroom. Depending on the lessons, the
students will work in a whole group, small group, in partners, or independently. With that said, the main aspects of the unit involves rebuilding the different models of Ptolemy and Galileo so the students can better understand Galileo’s trial and why that was such a big deal during this time period. The role of the educator is to lead them in the correct direction so they can be successful while making these important connections. Equally important, reinforce academic language, guide students to qualify their own research and discoveries, and allowing them to showcase their conclusions through different modes.

Towards the end of the unit, the students will take a field trip to the Griffith Observatory where they will participate in one of their monthly “Star Parties” to seek more knowledge and seek out inspiration on how amazing Galileo’s discovery was. This field trip is essential to the unit because students have to have opportunities to see planets through telescopes, meet actual astronomers, and explore the museum. During the field trip, students will take notes and document things they see that can enhance their own project. The field trip will also have a docent so students can ask meaningful questions and will be able to participate in . This field trip also prompts followup discussions in class.

A prerequisite for this unit is for students to be able to infer, compare and contrast, and explain the key aspects of the three laws of motions to meet the California Common Core Standards and NGSS. This unit not only meets the standards, but exceeds them being that this unit is driven by the constructivist approach. This unit requires the students to dig deeper and go well beyond the expectations of the content standards. They are researching, applying what they know in in different facets, and are pushed to go above and beyond the norm. The students are functioning like astronomers and physicists. Moreover, they are covering other areas of academia
such as writing, literacy, history, math, and the arts. It also enhances their communication and social skills as well. This unit is significant because it is built around the students creativity and discoveries; its personal and original; therefore, making it extremely meaningful.

Overall, this unit is student driven with the guidance of the teacher and standards. The teacher merely prompts the student’s learning by simply putting them in various positions to invent, explore, create, and analyze. It is ideal for all students because it is nontraditional making learning more fun.
CHAPTER 4: IMPLEMENTING THE CONSTRUCTIVIST APPROACH IN A SCIENCE CLASSROOM

This chapter showcases what a unit would look like using the constructivist approach to learning in sequential order. Not only are lessons provided, but also rubrics, pictures, primary sources, and detailed essential questions. The lesson plans are organized in a way that scaffolds students and helps assist the teacher with providing their students with an optimal learning experience. This unit is inspired by the merging of content areas as well as ELA, common core, and NGSS standards. Throughout the unit, it will become evident that the students take the control over their learning, but with the guidance of their teacher. The teacher’s role is merely to guide the students so they can gain a deep understanding of the essential questions as well as assess them along the way to ensure they are meeting the objectives.

At the end of this unit project, the students will have an enriched understanding of the evolution of science, have insight as to why people have different perspectives, and have developed strong critical thinking skills through examining the medieval times, Ptolemy, and Galileo. It is important to note, that the unit is not specifically about this time period, it is about using this time period as an example for how science has evolved, the importance of evidence, and being able to see things from different perspectives. Coupled with these key elements, question information in a way that is based on logic, understanding, and experience. In addition, this unit plan reveals why the constructivist approach should be integrated into science classroom. Students need to acquire strong critical thinking skills to be competitive in today’s world.
Pre-Planning: Introduction to the Unit

Objective: At the end of the lesson, the students will have a grasp on how science was viewed and treated during the medieval times by working together to develop a series of posters as a class that illustrate five specific religious viewpoints pertaining to science.

Lesson Goal:
This lesson will start the actual unit. Prior to this unit, the students would have learned about the scientific method, conducted various labs using the scientific method, and have a clear understanding of why everything is based on logic and evidence. This specific lesson is intended to enlighten the students how people thought during the medieval times. That science was solely based on religious world views and logic was never a factor.

During the lesson, the students will construct their own knowledge on why a society felt science should be based on religious viewpoints. They will make connections from their own life, to medieval life styles.

Why did people during the medieval times associate science to their religious beliefs? My goal is for the students to see that history, is absolutely essential, and intricately connected to science innovation and discoveries. I want to expose them to how influential a belief can be to a society and the value of being an independent person and thinker. In addition to, I want my students to see the value of considering all points of view; especially, in the realm science.

For this lesson to be successful it is imperative for the students to have a foundation in knowing what scientific method is, what science is (broad terms), and that how we approach science is vastly different now than before. If the students fail to see that science has evolved over time due to world views, they will have a difficult time conceptualizing why Galileo was on trial for disagreeing with the Earth being the center of the universe. In other words, this is a critical scaffold for the bigger picture of this unit.

CA Content Standards:
7.6 Students analyze the geographic, political, economic, religious, and social structures of the civilizations of Medieval Europe.
CA ELD Standards:
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

**Emerging**: 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

**Expanding**: 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

**Bridging**: 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

**Materials and/or Technology**: Chart paper, markers, tape, medieval times music recordings, and speakers.

**Vocabulary**: World views

**Classroom Management/Room Arrangements/Student Groupings**: To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model, scaffold, read aloud, and provide visual aids. Students will also work in small groups (3 to 4 people) where I will walk around and assist as needed.

**Modifications**:
- Sentence starters for my English language learners.
- Students with IEPs and 504s will sit in the front row
- My TA (Spanish speaker) will pre-teach the vocabulary prior to the lesson to accommodate my English language learners.
- Visual aids will be provided.
- Repetition and scaffolding will benefit all students.

**Assessment**:
- **Informal Assessment**: Takeaway Post-its
• **Informal Assessment**: Walking around listening to their discussions as they construct their own knowledge about medieval viewpoints.
• **Formal Assessment**: Writing Rubric for their poster.

**Method of Scoring:**
• Rubric
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction/Hook</strong></td>
<td>At the beginning of the lesson, I will project a picture on to the projector screen. Each student will then write down three things that come to mind and three things that they can relate to from the picture.</td>
</tr>
<tr>
<td><strong>2 Minutes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Directed Lesson</strong></td>
<td>After the students examine a work of art from the medieval times. I will then state the objective and define what a world view is.</td>
</tr>
<tr>
<td><strong>15 Minutes</strong></td>
<td>Next, talk about the power of the church during the medieval times and show a 7 min video. Medieval Realms - The Power of the Church</td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Student Led Directed Lesson</strong></td>
<td>After the directed lesson, the students will then be broken into small groups. They will each be assigned a poster in some area of the classroom. On each poster, there will be an essential question related to the power of religion during the medieval times. The students will write and draw a picture on their personal thoughts. When they hear medieval music, they will then move to the next poster. They will complete this poster until they have commented on each.</td>
</tr>
<tr>
<td><strong>20 Mins</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Whole Group Read Aloud, Group Reread, Written Summary.</strong></td>
<td>After the students chart down their thoughts, as a class, we will read them aloud. The students will led the conversation on medieval view points and the influence the church had on that society. Students will respectful challenge one another’s view points, but I will encourage them to be mindful that was the way during that time period.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Closure</td>
<td>I will restate the objective…</td>
</tr>
<tr>
<td></td>
<td>Then show a different piece of art work that is connected to the discussion they just had. This is a glimpse of what is to come.</td>
</tr>
<tr>
<td>Day 1</td>
<td></td>
</tr>
</tbody>
</table>
# RUBRIC

**Student’s Name_________________________ Date______________**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Point Value</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student wrote a thought opinion and drew a picture on each poster. 5 Points Each</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Student participated in whole group discussion.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>During the discussion, student appeared to follow the conversation.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Student was able to explain what a world view was.</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Point Value______________/50
Lesson Goal:
This mini lesson will zoom in on how the world has viewed science over our history. This is extremely important because it sets up the differences between Ptolemy and Galileo’s way of thinking. Plus, the impact region had on not science around the world. This is important for students to understand that different religious groups had their own opinion of science and it was not just during the medieval era. In other words, science has truly evolved over a very long period of time. But, in this unit, we are only looking at one specific time period. At the end of the mini lesson, the students will have placed 7 religious perspectives on science from different time periods on a map with a partner. Then present their findings to the class.

Skills: This mini-lesson gives the students the opportunity to work on their researching skills as well as practice public speaking (both a scaffold for future lessons).

Materials and/or Technology: Computers, card stalk, sharpies, push pins, and individual world maps.

Vocabulary: World views

Classroom Management/Room Arrangements/Student Groupings:
To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model, scaffold, read aloud, and provide visual aids. Students will also work in small groups (3 to 4 people) where I will walk around and assist as needed.

Assessment:
• Informal Assessment: Walking around a listening to the students while they are researching.
• Formal Assessment: Map with Facts

Method of Scoring:
• Rubric
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>To begin the lesson, I will recap what a world view is. Next, explain/model their mini research project.</td>
</tr>
<tr>
<td></td>
<td>The students will work with a partner to acquire religious world views during different time periods on science. They may focus on any of the following, but are certainly not limited by them. The students should use their prior knowledge and personal experiences to research this topic.</td>
</tr>
<tr>
<td></td>
<td>Inventions                                                                                                                                  Perspectives</td>
</tr>
<tr>
<td></td>
<td>Tools                                                                                                                                     Belief(s) of Religious Group</td>
</tr>
<tr>
<td>Conclusion</td>
<td>After the students find their information, they will then present their poster to the class. They will share only 3 of their facts that they fill to be the most profound. Upon them presenting, their peers will have the opportunity to provide commentary, ask questions, and/or make connections to their own findings. This section will be student led.</td>
</tr>
<tr>
<td>Example of Project</td>
<td></td>
</tr>
</tbody>
</table>
### Map Rubric

**Student Name___________________________________________ Date______________**

**Student Name___________________________________________**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Point Value</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students found 7 historical facts that pertain to both science and religion.</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>10 Points/Fact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students pinned them on the correct part of their map.</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Fact to Country/City/Continent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Points Each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students presented 3 out of their 7 facts from their map to</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>their peers. Also, students were able to engage in commentary with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>their peers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Map project is neat with less than 3 errors.</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Point Value__________/100
Pre-Planning:

Objective: After watching a BBC documentary about the middle ages and an introductory power point presentation on Ptolemy, the students will recreate a 3D model of Ptolemy’s theory and attach a summary of medieval thought in relation to the idea that the Earth was the center of the universe using Ptolemy’s written work and a scholarly document about medieval times following a rubric.

Lesson Goal:
This lesson is an important scaffold for students to grasp the complexity of the evolution of scientific thought, logic, and evidenced-based reasoning. In this lesson, the students will begin to learn about Ptolemy’s theory in greater detail which consisted of the Earth being in the center of our universe founded on Aristotle’s premise. To do this, the students will explore the origin of the theory and gain a clear understanding as to why the use of the scientific method was not even an option during medieval times. [Note: It is critical for the students to understand the “why” behind this theory versus the science at this point in the unit. This will help them have a greater appreciation the scientific revolution and the enlightenment period for that is when science began to flourish, incorporate human thought, and catapulted brilliant thinkers.]

During the lesson, the students will connect their prior knowledge in order to make meaningful science connections to relevant historical facts. To execute this, the students will time travel back and think like Ptolemy and many others by recreating a 3D model of Ptolemy’s theory of the universe. The model will be constructed with Earth being in the center of the universe and the other planets orbiting around it. Upon making the model, the students will use a document written by Ptolemy and write up a summary explaining both the model and theory. The objective is for them to gain insight as to why this theory was considered to be true in spite of there being a lack of evidence, based on God rather than logic, and zero scientific rational.

How can history help us better understand science?

My goal is for my students to see that history is absolutely essential, and intricately connected to science innovation and discoveries. I want to expose them to how influential a belief can be to a society and the value of being an independent person and thinker. In addition to, I
want my students to see the value of considering all points of view; especially, in the realm science.

For this lesson to be successful it is imperative for the students to have a foundation in reading scholarly text (that is modified to accommodate their understanding and reading levels), the scientific method, astronomy, and medieval times.

**CA Content Standards:**
7.6 Students analyze the geographic, political, economic, religious, and social structures of the civilizations of Medieval Europe.

**CA ELD Standards:**
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

**Emerging:** 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

**Expanding:** 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

**Bridging:** 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

**Materials and/or Technology:** Ptolemy Video Clip, Primary Source: Ptolemy’s Solar System Document, Primary Source: Ptolemy written work, pencils, chart paper, paint, mod-podge, clay, wire, hot glue, hot glue gun, tape, computers, printer, printer paper, clay knives, and water.

**Vocabulary:** Medieval, solar system, orbit, and Ptolemy.

**Classroom Management/Room Arrangements/Student Groupings:**
To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model, scaffold, read aloud, and provide visual aids. Students will also work in small groups (3 to 4 people) where I will walk around and assist as needed.
**Modifications:**
- Sentence starters for my English language learners.
- Students with IEPs and 504s will sit in the front row.
- My TA (Spanish speaker) will pre-teach the vocabulary prior to the lesson to accommodate my English language learners.
- Visual aids will be provided.
- Repetition and scaffolding will benefit all students.

**Assessment:**
- **Informal Assessment:** Takeaway Post-its
- **Informal Assessment:** Walking around a listening to their discussions as they write their summary and build their 3d model on Ptolemy’s theory.
- **Formal Assessment:** Writing Rubric for their Ptolemy summary.
- **Summative Assessment:** A completed 3D model of Ptolemy’s theory on the universe according to the rubric guidelines.

**Method of Scoring:**
- Rubric
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction/Hook</strong></td>
<td>At the beginning of the lesson, I will have a jar full of salt. I will ask the students to write down what they think is in the jar. This jar of salt will lead to a discussion on what is actually in the jar. The goal: Looks can be deceiving. So is evidence needed?</td>
</tr>
<tr>
<td><strong>Review/Scaffold</strong></td>
<td>Next, I will reteach the essential questions from two previous lessons on the medieval times and Ptolemy by turning a video into a game. Students will watch the 3 minute video. After the video, I will then ask questions based on the key points. A buzzer will be placed in front of two students, I will ask a question, and the first student to buzz in and answer correctly will stay up while the other one sits down. This is merely a quick review game to increase engagement, reenforce academic language, and prepare for the actual lesson.</td>
</tr>
<tr>
<td><strong>Student Led Directed Lesson</strong></td>
<td>State the objective…</td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td>Next, I will project a large image of Ptolemy’s solar system model onto the projector screen. The students will then make observation on what they see. As they make their observations, I will then chart them to the left of the image. The students are constructing their own knowledge based on what they are seeing; I am merely mediating the conversation and infusing essential questions.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Whole Group Read Aloud, Group Reread, Written Summary.</strong></td>
<td>After charting down the students observations, as a class, we will read Ptolemy’s theory on the Earth being the center of the universe. Different reading strategies will be integrated to ensure the students are comprehending the text. Once the text has been read as a whole group, the students will reread with their small groups and write a brief summary interweaving the key elements to Ptolemy’s theory following a rubric.</td>
</tr>
<tr>
<td><strong>40 Minutes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Hook/Review</strong></td>
<td>Find Someone Who Game: Students will be given a sheet of paper with a series of questions and have to gather signatures. The student with the most signatures are the end of 3 minutes wins.</td>
</tr>
<tr>
<td><strong>3 Minutes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Day 2 &amp; 3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Recap…</strong></td>
<td>Being that the students have explored Ptolemy’s written work and written their summary, they will then begin to make their 3D model of his version of the universe. I will model various ways in which they can make their model, but leave room for creativity and art integration. The students will continue to work with their same groups for this section of the lesson. Students will get two to three days to make nice models.</td>
</tr>
<tr>
<td><strong>Guided Instruction &amp; Modeling</strong></td>
<td></td>
</tr>
<tr>
<td><strong>40 Mins</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Day 2 &amp; 3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Note:</strong> On Day 3…The students will have their class time to work on their model.</td>
<td></td>
</tr>
<tr>
<td><strong>Closure</strong></td>
<td>I will restate the objective…</td>
</tr>
<tr>
<td><strong>Which will take place when the models are completed</strong></td>
<td>Next, project Ptolemy’s solar system back onto the projector screen and lead the students into a meaningful discussion on what they have learned after reading and replicating his theory. They will then orally draw conclusions, express their thoughts and opinions about the mindset of the medieval times to the image and perhaps their own model. After our concluding discussion, I will have the students independently write a brief takeaway from our two day lesson and post it on a new chart paper.</td>
</tr>
<tr>
<td><strong>10 Mins</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Note: This is a quick assessment for me to see if the objective has been met.</td>
</tr>
</tbody>
</table>
### Ptolemy 3D Model Rubric

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Point Value</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students correctly replicate Ptolemy’s solar system model.</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>• Earth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Moon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mercury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Venus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Jupiter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Saturn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D Model does in a creative way.</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

**Teacher Comment(s):**

![Diagram of Ptolemy's solar system model]
Lesson Goal:

The purpose of this three day lesson is to help the students understand the difference between reflection and refraction. This science lesson is intended to temporarily isolate the science concept from the bigger picture which is understanding perspectives and optics. In other words, a scaffold for the next lesson in the unit. It is important to set the students up for success while meting the NGSS standards at the same time. At the end of the lesson, the students will understand the difference between reflection and refraction by making a venn-diagram and execute a refraction science. Moreover, the students will build their own knowledge of the content which will help deepen their connection to the unit set in place.

What is the difference between reflection and refraction?

How does reflection and refraction pertain to science?

The essential goal is for the students to distinguish the difference between reflection and refraction so they can understand and appreciation the science being optics. Furthermore, have the ability to engage in an intelligent discussion about perspectives, the value of having scientific evidence, and the abilities to make connections to optic inventions such as the telescope. Without this background knowledge, the rest of the unit will be invaluable.

NGSS: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

NGSS: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.]
CA ELD Standards:
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

Emerging: 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

Expanding: 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

Bridging: 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

Materials and/or Technology: Scissors, cardboard, prism, and white paper.

Vocabulary: Optics, refraction, reflection, and illuminate.

Reflection: The throwing back by a body or surface of light, heat, or sound without absorbing it.

Refraction: The bending of a wave when it enters a medium where its speed is different.

Classroom Management/Room Arrangements/Student Groupings:
To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model every step of the lesson, and provide visual aids for each group as they conduct their experiment. Students will also work in small groups (3 to 4 people) where my TA and I will walk around and assist as needed.

Assessment:
- **Informal Assessment:** Listening to their answers as they participate in the whole group discussion.
- **Entry Level Assessment:** Graded lab venn-diagram & graded lab sheet.
- **Summative Assessment:** Did they fill out/explain the experiment using the scientific method?
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>I will create two different bubble maps; one on reflection and one on refraction. Students will be allowed to share their prior knowledge and/or what they think it is.</td>
</tr>
<tr>
<td>Day 1</td>
<td>Powerpoint Examples</td>
</tr>
<tr>
<td>Body</td>
<td>Once the students expressed their ideas and prior knowledge, we will then dive into the difference. Various examples will be projected onto the projector screen. As each image is projected, the students will connect their personal experiences to them. Upon the examples, the students will then create a venn-diagram showing the similarities and differences.</td>
</tr>
<tr>
<td>Day 1</td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Closure</strong></td>
<td>At the end of the lesson on day one, the students will watch a brief video</td>
</tr>
<tr>
<td></td>
<td>explaining the difference and similarities of reflection and refraction.</td>
</tr>
<tr>
<td></td>
<td>This is intended to provide another visual aid to accommodate the ELA</td>
</tr>
<tr>
<td></td>
<td>students.</td>
</tr>
</tbody>
</table>

| Day 1            |                                                                            |
|                  |                                                                            |

| **Introduction** | • Review rules and procedures for science experiments.                      |
|                  | • Model                                                                     |
|                  | • Distribute materials                                                      |

<p>| Day 2            |                                                                            |</p>
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment</strong></td>
<td>Students cut a slit in a large piece of cardboard. Then place the cardboard in a sunny window so that a shaft of sunlight shines through the slit. In one hand, hold a prism in front of the cardboard so that the sunlight passes through it. With the other hand, hold the sheet of white paper so that the light passing through the prism shines on. The students should see a rainbow of colors on the paper. The students will see white light is composed of all the colors on the spectrum.</td>
</tr>
</tbody>
</table>

After the students complete their experiment, they will finish their lab sheet. Once the lab sheet is completed, we will review the experiment as a whole group.
Complete your lab. Each section is worth 10 points.

Scientific Question

Background Research

Formulate a Hypothesis

Conduct an Experiment
Analyze Results


Conclude Results


Draw & Color a Picture of Your Experiment


Was your hypothesis correct or incorrect? Explain


Score_________________

WE CANNOT SOLVE OUR PROBLEMS WITH THE SAME THINKING WE USED WHEN WE CREATED THEM
Pre-Planning:

**Objective:** After reading Ptolemy’s theory on Earth, replicating a 3D model showing Earth as the center of the universe, having a lesson on reflection and refraction, and finally having a lesson on Galileo improving the telescope, the students will now conduct an optics experiment to learn about perspectives by using the scientific method and following a rubric.

**Lesson Goal:**

This lesson is a bridge between two major parts of history; the medieval times and the scientific revolution. With that said, this lesson essentially starts to unravel the birth of human logic and reasoning as it begins to be incorporated in scientific discoveries; the scientific method. Moreover, begins to show students what unfolded when religious theories were challenged and/or questioned by those who disagreed with that standpoint. From a non-bias delivery, students will be encouraged to formulate their own opinions on how science should be approached; this optics lesson is the catalyst for that. Equally important, the students should begin to indirectly explore if religion even be affiliated with science since it is typically based on faith not sight given the previous lessons.

During the lesson, the students will connect their prior knowledge in order to make meaningful science connections to relevant historical facts. To execute this, the students will attempt to disprove Ptolemy’s theories by using a modified version of Galileo’s approach to proving sun is the center of the universe. In this optics lesson, the students will learn about perspectives and how the advancement of optics helped disprove Ptolemy’s theory. The students would have had a lesson specifically on reflection and refraction prior to this lesson to make this important connection, have the capacity to think more deeply, and consider the value of evidence in science (things that can been seen). Again, the objective is for them to gain insight as to why this theory is more accurate then Ptolemy’s theory while be mindful of the time period.

*Can science and religion be one and the same?*

My goal is for my students to see that that perspective and observations were challenged during the medieval times, but later on absolutely essential, and intricately connected to science innovation and discoveries. In this optics lesson, I want my students to see the value of perspectives and points of view. Visible objects fall into two general categories: luminous objects (such as a computer monitor) that emit their own light and illuminated objects (the keyboard) that reflect light emitted by other sources. The students need to understand that our eyes see objects by detecting either emitted or reflected light, and under most circum
stances that light has to reach your eyes by traveling in a straight line. In other words, an unobstructed line of sight between a person and any object one is trying to view. My goal, is for the students to see why Galileo’s discovery about the universe was so significant; especially, during a time where logic and reasoning were not a factor. For this lesson to be successful it is imperative for the students to have a prior knowledge in light, reflection, refraction, 3D shapes, the scientific method, astronomy, the evolution of the telescope, the medieval times. Moreover, for learning why Galileo had to go to trial for his scientific advancements that were not based on religion, but were proven to be true.

**NGSS: MS-PS4-2.** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

**NGSS:** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.]

**CA ELD Standards:**
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

**Emerging:** 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

**Expanding:** 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

**Bridging:** 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.
Materials and/or Technology: Two tea candles, Matches or a lighter to light the candles, CD jewel case with one glossy, transparent surface, Dark surface (laying a black T-shirt flat on a table), and paperclips.

Vocabulary: Optics, refraction, reflection, and illuminate.

Classroom Management/Room Arrangements/Student Groupings:
To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model every step of the lesson, and provide visual aids for each group as they conduct their experiment. Students will also work in small groups (3 to 4 people) where my TA and I will walk around and assist as needed.

Modifications:
• A video on refraction and reflection prior to the lesson.
• Students with IEPs and 504s will sit in the front row during the directed instruction.
• My TA (Spanish speaker) will pre-teach the vocabulary prior to the lesson to accommodate my English language learners.
• Visual aids will be provided.
• Repetition and scaffolding will benefit all students.
• Visual-aids around the classroom
• Groups based on reading levels (they have to read the directions)

Assessment:
• **Informal Assessment**: Walking around a listening to their discussions as they conduct their experiment.
• **Formative Assessment**: Group participation, responses throughout the debate.
• **Entry Level Assessment**: Student interaction, comprehension questions during read aloud, and evidence of active listening to display understanding.
• Graded Lab sheet
• **Summative Assessment**: Students are able to execute the experiment getting the correct results.
  • Is it setup correct?
  • Did they fill out/explain the experiment using the scientific method?

Method of Scoring:
• Rubric
• Lab Sheet (Informal Assessment)
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction/Hook</td>
<td>At the beginning of the lesson, I will present the students with a Chalk Talk. The question will read…</td>
</tr>
<tr>
<td>2 Minutes</td>
<td>Is seeing really believing?</td>
</tr>
<tr>
<td>Reteach &amp; Directed Lesson</td>
<td>To begin the lesson, I will show the students a reteach video on video refraction and reflection.</td>
</tr>
<tr>
<td>Whole Group Discussion</td>
<td>Video: <a href="https://www.youtube.com/watch?v=xO-Q7go1i7A">https://www.youtube.com/watch?v=xO-Q7go1i7A</a> (A Scaffold)</td>
</tr>
<tr>
<td>15 Minutes</td>
<td>After the video, I will restate the difference between refraction and reflection then begin to go over their lab. Each student will receive a copy of the lab and the lab paper work.</td>
</tr>
<tr>
<td>Experiment</td>
<td>The students and I will fill out the first section of their lab sheets using the scientific method…Then I will model how to do the experiment…</td>
</tr>
<tr>
<td>Small Groups</td>
<td>First, working on a dark surface with the lights still on, the students will stand the CD case on its bottom edge. Open the CD case at a 90-degree angle.</td>
</tr>
<tr>
<td></td>
<td>Next, take one unlit tea candle and place it on the side of the CD case’s transparent panel nearest to one student. They need to be sure they can see its reflection.</td>
</tr>
</tbody>
</table>
|                                | **Questions…**  
Where in space does the reflected image appear to be?  
Why do you think this is?  |
|                                | Next, take the other unlit tea candle and place it on the other side of the transparent panel. Adjust the position of the second candle so that it’s in the same apparent location as the reflection of the first tea candle. |
|                                | Next, the students should move their heads around while looking at the second tea candle through the CD case so they can see the reflection of the first tea candle. |
|                                | Next, they will take a look at the orientation of the CD case and the tea candles from above. Note: The position of the two tea candles. |
|                                | **Question…**  
What's special about their positions relative to the CD case's transparent panel?  |
<p>|                                | Next, they will nudge the first tea candle away from the CD case slightly and observe what happens to the reflection. |
|                                | Next, nudge the second tea candle to match the apparent location of the first tea candle’s reflection. Then turn off the lights and light the tea candle located on the side of the transparent panel nearest to left side.. |
|                                | The students will work in small groups and conduct their experiment. |</p>
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture Example of the Experiment</td>
<td></td>
</tr>
<tr>
<td>Closure</td>
<td>The students will complete their lab sheets. Once they are done, we will go over it, and I will recap on what they just did. Then I will conclude the lesson by referring back to our chalk talk discussion. Could we have made that refraction discovery without seeing it?</td>
</tr>
</tbody>
</table>
Pre-Planning: Introduction to the Unit

Objective: Students will have a Q&A session with Mohammad, a guest speaker from the Griffith Observatory about their burning questions requiring our solar system, telescopes, and Galileo.

Lesson Goal: The purpose for having a guest speaker come into the classroom is to give the students an opportunity to have a meaningful conversation with an actual astronomy specialist. The students will be able to acquire additional information they would not necessarily get from their teacher and/or books. Also, the students will get to indulge in additional hands on activities for Mohammad will bring in various telescopes that equipment that astronomers use.

CA ELD Standards:
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

Emerging: 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

Expanding: 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

Bridging: 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

Materials and/or Technology: Pencil and prewritten questions.
Note: The Guest Speaker will Provide all Material
**Vocabulary**: Orbit, rotation, and optics.

**Classroom Management/Room Arrangements/Student Groupings**: To accommodate all learners the following strategies will be used throughout the lesson: Students will sit according to a predesigned seating chart to meet their academic needs.

**Modifications**:  
- Students will pre-write their burning questions

**Assessment**:
- **Informal Assessment**: Takeaway Post-its
- **Informal Assessment**: Antidotal notes on how they interact with the guest speaker.
- **Formal Assessment**: N/A

**Method of Scoring**:  
- No grade will be assigned, but students will have to write down answers to the preset questions.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| **Introduction/Hook**             | At the beginning of the lesson, I will introduce the guest speaker. I will review classroom rules and manners.  
| **2 Minutes**                     | Day 1                                                                                                                                 |
| **Note:**                         | **The students will be responsible for wiring three questions to ask Mohammad. They will be required to write down at least two answers down on their sheet.** |
| **Guest Speaker’s Presentation**  |                                                                                                                                              |
| **45 Minutes**                    | Day 1                                                                                                                                 |
| **Guest Speaker**                 | ![Guest Speaker Image](image.png)                                                                                                                                 |
| ![Los Angeles Image](image2.png)  |                                                                                                                                              |
guest speaker q & a

name____________________________________________________________

question:

answer:

question:

answer:

question:

answer:
**Pre-Planning:**

**Objective:** After learning about perspective, Ptolemy’s position on the universe, and reflection and refraction, the students will now indulge into Galileo’s position on the universe and how he argued that the sun is the center of our universe. At the end of the lesson, the students will create a 3D model of Galileo’s model of the universe.

**Lesson Goal:**
This lesson begins to unravel how religious views were now being questioned by scientists. That evidence was beginning to play a significant role resulting in science evolving and what ultimately led to the scientific revolution. Galileo’s discovery is monumental in this section of the unit because the students will now understand the value of perspective and be able to connect the dots by contrasting it with Ptolemy’s model they previously made and the literature they read. What is more, begin to understand world views with greater depth and understanding. They are now in a position to actually argue if science should be based on religion or evidence. They have acquired a significant amount of prior knowledge to be able to construct their own opinion.

During the lesson, the students will connect their prior knowledge in order to make meaningful science connections to relevant historical facts. To execute this, the students will now being to think like Galileo and recreate his 3D model of the universe. This model will be constructed with the sun now being in the center of the universe and the other planets orbiting around it all the way up to Saturn. Upon making the model, the students will use a documentation written by Galileo and write up a summary explaining both his model and theory which disproves Ptolemy’s theory. The objective is for them to gain insight as to why this theory was so controversial during the medieval times and begin to pursue complex thoughts about why religious groups were so against this theory.

*Why would new evidence and findings that could help better our understanding of the universe result in so much controversy?*

My goal is for my students to see that history, is absolutely essential, and intricately connected to science innovation and discoveries. I want to expose them to how influential a belief can be to a society and the value of being an independent person and thinker. In addition to, I
want my students to see the value of considering all points of view; especially, in the realm science.

For this lesson to be successful it is imperative for the students to have a foundation in reading scholarly text (that is modified to accommodate their understanding and reading levels), the scientific method, astronomy, and medieval times.

**CA Content Standards:**
7.6 Students analyze the geographic, political, economic, religious, and social structures of the civilizations of Medieval Europe.

**CA ELD Standards:**
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

Emerging: 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

Expanding: 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

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**Materials and/or Technology:** Galileo Video Clip, Primary Source: Galileo’s Solar System written work, pencils, chart paper, paint, modpodge, clay, wire, hot glue, hot glue gun, tape, computers, printer, printer paper, clay knives, and water.

**Vocabulary:** Medieval, solar system, orbit, and Galileo.

**Classroom Management/Room Arrangements/Student Groupings:**
To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model, scaffold, read aloud, and provide visual aids. Students will also work in small groups (3 to 4 people) where I will walk around and assist as needed.
**Modifications:**
- Sentence starters for my English language learners.
- Students with IEPs and 504s will sit in the front row
- My TA (Spanish speaker) will pre-teach the vocabulary prior to the lesson to accommodate my English language learners.
- Visual aids will be provided.
- Repetition and scaffolding will benefit all students.

**Assessment:**
- **Informal Assessment:** Takeaway Post-its
- **Informal Assessment:** Walking around a listening to their discussions as they write their summary and build their 3d model on Galileo’s theory.
- **Formal Assessment:** Writing Rubric for their Galileo summary.
- **Summative Assessment:** A completed 3D model of Galileo’s theory on the universe according to the rubric guidelines.

**Method of Scoring:**
- Rubric
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction/Hook</strong></td>
<td>At the beginning of the lesson, I will have a jar full of salt. I will re-ask the students to write down what they think is in the jar. Being that the students have done this before and we have had an in-depth discussion about not judging things based on sight, but perhaps on evidence, the students should have more thoughtful responses. Meaning…They should be asking questions that will help them to really decipher what is in the jar versus what they think is in the jar. NOTE: Call back hook! This will provide insight if the students are starting to see connections between lessons.</td>
</tr>
<tr>
<td><strong>Review/Scaffold</strong></td>
<td>As a class…We will review Ptolemy's theory and beliefs. It is important that the students truly understand not only his theory, but what it was based on.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Student Led Directed Lesson</strong></td>
<td>State the objective…</td>
</tr>
<tr>
<td>6 Mins</td>
<td>Next, I will project a large image of Galileo’s solar system model onto the projector screen. The students will then make observation on what they see. As they make their observations, I will then chart them to the left of the image. The students are constructing their own knowledge based on what they are seeing; I am merely mediating the conversation and infusing essential questions.</td>
</tr>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Whole Group Read Aloud, Group Reread, Written Summary.</strong></td>
<td>After charting down the students observations, as a class, we will read Galileo’s theory on the sun being the center of the universe. Different reading strategies will be integrated to ensure the students are comprehending the text. Once the text has been read as a whole group, the students will reread with their small groups and write a brief summary interweaving the key elements to Galileo’s theory following a rubric.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hook/Review</td>
<td>Students will be given labels that say Ptolemy and Galileo. There will be facts all around the class room regarding both scientists. The students will have three minutes to stick their labels on the correct facts.</td>
</tr>
<tr>
<td>3 Minutes</td>
<td></td>
</tr>
<tr>
<td>Day 2 &amp; 3</td>
<td></td>
</tr>
<tr>
<td>Recap...</td>
<td>The students have explored Galileo’s written work and written their summary, they will then begin to make their 3D model of his version of the universe.</td>
</tr>
<tr>
<td>Guided Instruction &amp; Modeling</td>
<td>The students will continue to work with their same groups for this section of the lesson. Students will get two to three days to make their models.</td>
</tr>
<tr>
<td>40 Mins</td>
<td>Note: On Day 3…The students will have their class time to work on their model.</td>
</tr>
<tr>
<td>Day 2 &amp; 3</td>
<td></td>
</tr>
<tr>
<td>Closure Which will take place when the models are completed</td>
<td>Once the students have completed their Galileo models. They will orally draw conclusions, express their thoughts and opinions about the mindset of the medieval times by comparing Galileo’s theory to Ptolemy’s. After our concluding discussion, I will have the students independently write a brief takeaway from our two/three day lesson and post it on a new chart paper.</td>
</tr>
<tr>
<td>10 Mins</td>
<td>Note: This is a quick assessment for me to see if the objective has been met.</td>
</tr>
</tbody>
</table>
### Ptolemy 3d Model Rubric

**Student Name___________________________________________ Date______________**

**Student Name___________________________________________**

**Student Name___________________________________________**

---

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Point Value</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students correctly replicate Ptolemy's solar system model.</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>- Sun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mercury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Venus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Earth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Jupiter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Saturn</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3D Model does in a creative way.</strong></td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

---

**Teacher Comment(s):**

---

![Diagram of the solar system with labeled planets](image)
Pre-Planning: Introduction to the Unit

Objectives:

Day 1: At the end of the lesson, students will produce a sketch/drawing representing their perspective of a solar system model placed in the center of the classroom.

Day 2: At the end of the lesson, students will analyze their peers art work and construct their own opinions based on their peer’s perspective, then write thoughtful thoughts and/or questions related to each piece of art.

Day 3: At the end of the lesson, students will take their prior knowledge and write one to two paragraphs on why they feel Ptolemy and Galileo had different perspectives of the solar system.

Lesson Goal:
This is an important three day lesson in this unit because it teaches perspective, different viewpoints, and is a scaffold for the students to better understand the way in which Galileo and Ptolemy saw the Earth in our solar system. Moreover, the differences between religious and logic base view points in regards to science. In addition to, this lesson also gives students the opportunity to work independently and explore their own position on these key scientists. Furthermore, it also integrates the art standards with science. Being that at the beginning of the unit, art is used to depict religious views in science; therefore, it is important to show the students these key connections.

During the lesson, the student’s chairs will form one large circle. In the middle of the circle, will be a stand with a solar system model placed on top. Depending on where the student is sitting, will determine what their sketch looks like. At the end of day 1, each student’s picture will be carefully taped to the wall and available for other students to analyze it. On day 2, each student will walk around and analyze the other students art work. They will compare and contrast their perspectives to their peers. Again, this is a scaffold for how religious and evidence based view points differed during the medieval times.

NGSS: ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

Visual Art Standards: Analyze Art Elements and Principles of Design
1.3 Identify and describe the ways in which artists convey the illusion of space (e.g., placement, overlapping, relative size, atmospheric perspective, and linear perspective).

3.0 HISTORICAL AND CULTURAL CONTEXT
2.2 Use different forms of perspective to show the illusion of depth on a two-dimensional surface.
3.2 Compare and contrast works of art from various periods, styles, and cultures and explain how those works reflect the society in which they were made

CA ELD Standards:
Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

Emerging: 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

Expanding: 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

Bridging: 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

Materials and/or Technology: Pencil, charcoal, sketch paper, eraser, solar system model, 1 large box/stand, chairs, and medieval music.

Vocabulary: Perspective and point of view.

Classroom Management/Room Arrangements/Student Groupings:
Before the lesson, the rules of the classroom will be reviews and the expectations will be set. Students will recall the rules to ensure a positive learning environment.

Modifications:
• Students will sit next to students that do not disrupt them.

Assessment:
• Informal Assessment: Check list, and discussion at the end of the lesson.
• **Formal Assessment:** N/A

**Method of Scoring:**

• Students will be graded on participation and hard work to sketch their perspective of the solar system model.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction/Hook 2 Minutes Day 1</td>
<td>Students will walk into a redesigned classroom (taking them out of their comfort zone). They will sit in the chair with their name on it. Once everyone is seated, I will then write the word perspective on the board. I will create a bubble map brainstorming all their ideas. Upon brainstorming, I will then state the objective and introduce the lesson.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>45 Minutes</td>
<td>The students will sketch the solar system model while listening to medieval music (primary source).</td>
</tr>
</tbody>
</table>

Day 1

Example of a class painting ....
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 2</td>
<td>On day two, the students will walk around the classroom and look at their peers perspective art. They will use their comment card to jot down things that speak their interest, refer back to their prior knowledge, and infuse a burning question. They will be given 3 minutes at each student's drawing and then move on to the next.</td>
</tr>
</tbody>
</table>

Once the students had a chance to look at each piece, we will then have a meaningful conversation about perspectives. Students will be able to share their great ideas and ask their fellow classmates questions. This is a student led conversation.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 3</td>
<td>On day three, the students should have a deeper understanding on perspectives. Now, the students will write a brief reflection on why they feel Ptolemy and Galileo had different perspectives on our solar system. Students will be guided to construct their own meaning based on all the previous lessons. They may also share their reflection to the class.</td>
</tr>
</tbody>
</table>
Write one to two paragraphs explaining how your perspective differed from one of your peers.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Why is understanding perspectives important in science?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Pre-Planning:

Objective: After learning about the Medieval Times (from a scientific standpoint), Ptolemy, Galileo, and perspectives in great depth, the students will now decide if it was fair for Galileo to be put on trial for his scientific discoveries based on evidence by having the students debate based on facts from Galileo’s trial, Galileo’s literary work, and previously read scholarly articles on Ptolemy, and the Medieval times.

Lesson Goal:

In our final lesson, the students will be divided into two groups; in favor and not in favor of sending Galileo to trial. They will be given a card at random and then forced to take their prior knowledge and defend their side. This lesson is for the students to reenact the times in with Galileo lived and further their understanding of how difficult it was to advance in science because of one’s religious beliefs.

At the beginning of the lesson, the students and I will read the main events of Galileo’s trial and pieces of his own literary work. Upon reading, they will then begin their debate. The debate will be student led, but as the teacher, I will ensure it doesn’t go off course to prevent the debate from losing meaning. In order for the debate to be successful, the students will be given time to make arguments with their group. This will be a reteach moment, allow the students to work with others, and enrich the debate. Moreover, give the students the opportunity to annotate written text, identify key information, and summarize information.

End of Unit Essential Questions

Revised Repeat Essential Question: How can history help us better understand science?
Repeat Essential Question: How can religion and science be one and the same?
Repeat Essential Question: Does one have to see in order to believe?

My goal is for my students to see that history, is absolutely essential, and intricately connected to science innovation and discoveries. I want to expose them to how influential a belief can be to a society and the value of being an independent person and thinker. In addition to, I want my students to see the value of considering all points of view; especially, in the realm of science. For this lesson to be successful it is imperative for the students to have a foundation
in reading scholarly text (that is modified to accommodate their understanding and reading levels), the scientific method, astronomy, perspectives, and medieval times.

**CA Content Standards:**

7.6 Students analyze the geographic, political, economic, religious, and social structures of the civilizations of Medieval Europe.

**NGSS:**

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

**CA ELD Standards:**

Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language.

- **Emerging:** 12. Selecting language resources a. Use a select number of general academic words (e.g., cycle, alternative) and domain-specific words (e.g., scene, chapter, paragraph, cell) to create some precision while speaking and writing.

- **Expanding:** 12. Selecting language resources a. Use a growing set of academic words (e.g., cycle, alternative, indicate, process), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, and antonyms to create precision and shades of meaning while speaking and writing.

- **Bridging:** 12. Selecting language resources a. Use an expanded set of general academic words (e.g., cycle, alternative, indicate, process, emphasize, illustrate), domain-specific words (e.g., scene, soliloquy, sonnet, friction, monarchy, fraction), synonyms, antonyms, and figurative language to create precision and shades of meaning while speaking and writing.

**Materials and/or Technology:** Primary Source: Ptolemy’s Solar System Document, Primary Source: Ptolemy written work, Galileo’s literary work, Galileo’s trail transcript, pencils, chart paper, and index cards.

**Vocabulary:** Accused, defendant, plaintiff, and evidence.

**Classroom Management/Room Arrangements/Student Groupings:**

To accommodate all learners the following strategies will be used throughout the lesson: SDAIE strategies, the Socratic method, project based learning will be integrated, and the constructivist approach to learning. In addition to, I as the teacher will model how the debate will unfold, scaffold, read aloud, and provide visual aids. Students will be divided into two
groups and design an argument for their debate. I will be with one group and my TA will be with the others.

**Modifications:**
- Sentence starters for my English language learners.
- Students with IEPs and 504s will sit in the front row (during the read aloud)
- My TA (Spanish speaker) will pre-teach the vocabulary prior to the lesson to accommodate my English language learners.
- Visual aids will be provided.
- Repetition and scaffolding will benefit all students.
- Modified versions of the trial and Galileo’s text will be passed out.

**Assessment:**
**Formative:** Group participation, responses throughout the debate.
**Entry Level:** Student interaction, comprehension questions during read aloud, and evidence of active listening to display understanding.

**Method of Scoring:**
Participation Only
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction/Hook</td>
<td>I will play the following video clip without the sound…This will be my hook</td>
</tr>
<tr>
<td>2 Minutes</td>
<td>to the lesson. Video Clip: <a href="https://www.youtube.com/watch?v=M7A-cJGIDgA">https://www.youtube.com/watch?v=M7A-cJGIDgA</a></td>
</tr>
<tr>
<td>Directed Lesson</td>
<td>As a whole group, we will read key components of Galileo’s trial and sections</td>
</tr>
<tr>
<td>30 Min</td>
<td>of his literary work. Upon reading, I will then ask a series of comprehension</td>
</tr>
<tr>
<td></td>
<td>questions to ensure the students understand why he was sentenced to trial.</td>
</tr>
</tbody>
</table>

After the readings…I will then explain our class debate. Each student will pick a card from a jar at random and then sit with their groups. The students will get 15 minutes to collaborate and decide on the key points to make their argument.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debate</td>
<td>Once the students have organized their arguments...The debate will begin. The students will lead the debate by essentially reenacting this trial using actual text from this time period. Students on the Galileo side must present scientific evidence. Those students on the Ptolemy side, but defend with religion.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Explanation</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Closure</td>
<td>I will project the essential questions onto the protector screen…</td>
</tr>
<tr>
<td>10 Mins</td>
<td><em>Can history help us better understand science?</em></td>
</tr>
<tr>
<td></td>
<td><em>Can religion and science be one of the same?</em></td>
</tr>
<tr>
<td></td>
<td><em>Does one have to see in order to believe?</em></td>
</tr>
<tr>
<td>Primary Source</td>
<td><img src="image" alt="Primary Source Image" /></td>
</tr>
</tbody>
</table>
Assessments

Being that this is an in-depth unit, assessments are needed to check for student understanding. Within each lesson, there is a form of assessment(s) linked to ensure each student is retaining the information needed to be successful. Also, different types of assessments to accommodate different types of learners. The constructivist approach does encourage students to build upon their own knowledge, but the teacher plays a critical role in ensuring it is done both accurately and appropriately validating that each student is meeting the standards.

The students will have pre and post assessments to gauge their learning and understanding of the content being taught. Students will have completed different assignments throughout that will be graded using a rubric. They will also reenact Galileo’s trial, recreate Ptolemy’s solar system model, and present their findings. Students understanding will also be gauged by the way in which they ask and answer questions as well as how they communicate with their peers. These different assessments accommodates all the students by allowing them to showcase what they know in various ways. As presented in the unit, formative and summative assessments are used at various stages. These various assessments are essential to this unit.
CHAPTER 5: CONCLUSION

Albert Einstein once said, “Education is not learning facts, but training the mind to think.” It has become evident that today’s students believe learning is simply memorizing information for a quiz and/or test. As previously stated, students tend to lack understanding as to why they are learning specific concepts, and how these concepts are intricately connected to the world in which they live. Nonetheless, students tend to be unable to see how science connects to other areas of academia, and rarely question what it is they are actually learning (which is critical in science). The effects of the constructivist approach to learning is significant. Because of its significance, the constructivist approach should be utilized in all science classrooms so students can expand their intellect to exceed grade level expectations.

In a world that is rapidly changing, becoming more and more competitive, and relying on independent and innovative thought, the constructivist approach to learning is one of the best ways to ensure young minds acquire the skills they need to be extremely successful. As educators, it is imperative that we nurture our student’s life experiences, but delicately introduce them to the concepts they need in order to strive in the world in which we live. Equally important, encourage them bring their self to the concepts to further and deepen their understanding while making profound discoveries. Again, in a world that is dependent on imaginative intelligence, the only solution is to bring the constructivist approach to learning.


Tanase, M., & Leavitt, T. (2011). The Impact of Teacher Education Programs on In-Service Teachers in China and USA. Online Submission