

## Behind the Mask of Science

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### Introduction

Our state standards require 7<sup>th</sup> grade students to learn Isaac Newton's three laws of motion. Yet most students believe science topics such as these laws are cut and dry; they only need to learn the facts. Not only do I want my students to learn the laws, but also I want them to know how Newton arrived at these laws. There was much more behind the laws of motion than an apple falling from a tree! In science, the old cliché, 'there's more than meets the eye' holds true. Science is like a mask, and discovering what is behind the mask will cause students to have a greater interest, understanding, and appreciation of science. When students are able to uncover truths on their own, they take control of their knowledge and understanding.

Masks have been used for various reasons since prehistoric times. For certain rituals, many indigenous Australian, African, Native American, and South American tribes created and wore masks that resembled animals. These masks were thought to transform the wearer into the animal or to invoke the spirit of the animal. Many tribes also created funeral masks during burials and sacrifices. Masks have also been used for entertainment. Western theater has a history of Greek actors wearing masks to better convey characters' feelings to the audience. Perhaps the most recognizable are the tragic and comedic masks during the 17<sup>th</sup> and 18<sup>th</sup> century; masquerade balls were held in which masks were worn as a sort of folly. Despite the purpose of the mask, the universal function of all masks is to hide or disguise something. In the musical The Phantom of the Opera, the phantom wears a mask to hide his disfigured face. It provides a façade. This is probably the most noted mask in modern theater.

Although theater and science are thought to be very dissimilar, they both share a commonality- the mask. Much like the mask worn by the phantom, science also bears a mask of deceit and darkness. The façade of science is one of intelligence, humanitarianism, success, and the progression of mankind. However, as the cliché would have it, "all that glitters is not gold". There have been many instances throughout history in which the process of scientific discovery has been ambiguous, controversial, and political. For example, who was the first person to discover oxygen? Two men are credited with the discovery because no one knows who was first. Isaac Newton is known as the father of modern physics, but who was he really? What obstacles did he overcome to attain such an accolade? Do you think you have anything in common with great scientists? Analyzing questions like these and discovering the answers to questions like

these will serve as the basis of this unit. Students will examine and analyze what is behind the mask of science through use of plays and visual arts.

## **Rationale**

I have always loved history and reading, so I enjoyed simply reading about science when I was younger. However, this is not true of most of the students today. I discovered I was a scientist when I was 19 in my sophomore year of college. Organic chemistry was initially foreign to me. It was unlike anything I had ever read about science and it was a difficult subject to master. After a few weeks, I realized mastery was a very lofty goal and I just wanted to pass the course. My moment of inspiration came one day in lab. After studying polymerization for hours, I now had to perform it in lab. I remember mixing the chemicals, noting the types of reactions occurring, monitoring the percent yields, then Eureka! I placed the pipette into the smoking test tube and slowly pulled out a nylon polymer. I couldn't wait to call my mother to tell her I could now make my own pantyhose! That is the excitement I want each of my students to experience in science. After that day, I did not mind the difficulty of Organic chemistry because it was alive. I believe if students truly take an interest in science, they too will forget about the difficulty of the subject.

When this school year began, I surveyed my students to find out how they defined science. Most said science is how scientists study things and do experiments to find out new information. When I asked how many students enjoyed science, only about fifty percent of my students raised their hands. I later found out that many students didn't raise their hands because for them science in school had been reduced to reading and memorizing facts about science. A perfect example of this is the 'scientific method'. Most of my students can recite the steps of the scientific method, but when asked to apply it to a fictitious scenario they were stumped. Their science experience did not involve experimenting and discovery; this is why many students feel that they are disconnected from science.

Before I could design a unit that would excite students about science, I had to analyze the demographics of my classroom. The student body of the middle school is predominately Caucasian. The demographic breakdown is 55% Caucasian, 23% African American, 15% Hispanic, 3% Asian, 3% Multiracial, and .03% American Indian students. I teach six science classes total. Our middle school is on an A day-B day schedule, which means I teach three classes of students on Monday, Wednesday, and Friday, then classes of different students on Tuesday and Thursday. The class sizes range from 23-30 students. The academic abilities of the students in each class vary greatly. In one class I may have a few students reading three or four grades above grade level, a few who have been retained, and two or three who have only been speaking English for a couple of years. The motivation level also varies in my classes. There are students who

come to class each day eager to learn and excel, those who do just enough to pass, and those who desire to do well but require extra help. Creating lesson plans to stimulate and educate groups of students as heterogeneously mixed as mine can be a seemingly daunting task at times. I designed my unit with this perspective in mind.

The three focus topics for this unit are the discovery of oxygen, the real life of Isaac Newton, and the scientists who contributed to Newton's laws of motion. I chose these particular topics because they are all related to the North Carolina Standard Course of Study for seventh grade (this will be discussed in depth in the standards section of the unit). You can choose any science topics you want to and simply adapt them to fit the model of this unit. For example, if covering space exploration is one of your state objectives, instead of stopping at the basics, (planets, technology, and discoveries) allow students to look behind the "mask" of space exploration by examining the risk involved. Providing information and designing activities related to the Challenger and Apollo 13 voyages would be a great place to begin. The process of looking behind the "mask" of science lures students into the subject matter by exposing them to some aspect they can relate to or that they would find interesting. This unit is aligned to the North Carolina Standard Course of Study for seventh grade language arts and science. The goals and objectives are listed as *Figure 1* in the appendix.

## **Strategies**

### Multiple Intelligence

Not all students learn in the same manner, neither do they have the same affinities for content. In an educational digest, authored by Amy C. Brualdi, Howard Gardner's Theory of Multiple Intelligences is discussed. Gardner recognizes seven intelligences: Logical-Mathematical, Linguistic, Spatial, Musical, Bodily-Kinesthetic, Intrapersonal, and Interpersonal.<sup>1</sup> He believes everyone is born with each of these intelligences, but some are simply more developed than others. This could possibly explain some students' lack of motivation in science class. Maybe the content itself is not the problem, but the manner in which it is being delivered. Recognizing these issues was the first step in creating meaningful activities for my unit. My next step was to use differentiated instruction in delivering the content to my students.

### Differentiated Instruction

Differentiated instruction (D.I.) is an approach to planning in which multiple strategies are incorporated into one lesson to ensure that the individual needs of each student are met.<sup>2</sup> I am a huge supporter of D.I. because it meets the social, emotional and academic needs of students by allowing each individual the opportunity to contribute. This often time raises the self-esteem of students. This approach to instruction works great in

classrooms such as mine, where the academic ability, motivation, and types of intelligences vary greatly.

Some activities in this unit involve reading and analysis of text. These activities are geared toward students with Linguistic intelligence. The reading activities will also require a degree of introspection and self-reflection. Students with Intrapersonal and Interpersonal intelligences will be motivated to participate in these activities. I am also going to rely on the use of several Thinking maps as a way for students to visually present their ideas. For students with Spatial intelligence, or those who are creative, using Thinking maps to display their ideas is more exciting than simply creating a list.

### Thinking Maps

Thinking maps are similar to graphic organizers, such as Venn diagrams and webbing, but they are based on fundamental thinking skills.<sup>3</sup> There are eight thinking maps, and each one is used to display a different thought process.<sup>4</sup> According to David Hyerle and Chris Yeager, authors of *Thinking Maps: A Language for Learning*, “students who consistently use the same visual pattern for a specific thought process soon have visual patterns for thinking.”<sup>5</sup> This is why I chose to use thinking maps, rather than simply asking students to write a summary paragraph after reading each text of the unit.

### Scaffolding

I teach a number of students who are uninterested in writing unless it involves artwork. For these students, I have incorporated an activity that will allow them to create a graphic novel. Although writing is involved, the students will not mind because they will enjoy the sketching component of it. Even though I feel as if the D.I. approach to my unit will allow each student to be successful, for some I will still have to provide scaffolding.

Scaffolding in the construction arena means providing temporary support until the edifice is able to stand alone. In terms of education, scaffolding practically means the same thing.<sup>6</sup> An educator provides temporary support to his or her students until they are able to work independently. I will use scaffolding throughout my unit to ensure student success. The first step in scaffolding is to identify the goal. Once I determined the objective or destination of the activity, I had to design a road map for the students to get there. One example of scaffolding in my unit involves the graphic novel activity. The objective of the activity is for the students to create a graphic novel, which illustrates and explains Newton’s three laws of motion. First, the students will have to understand how the laws relate to motion. This will be accomplished through lecture, discussion, reading Newton’s *Laws of Motion* graphic novel. Once the laws are understood, I will provide the students with a copied page from the novel in which a law is being demonstrated and the words have been deleted. The students will be responsible for analyzing the illustrations and adding appropriate dialect according to the law being depicted. After

this part of the activity has been completed I will correct any mistakes and discuss any misconceptions with the students. Next, the training wheels come off. The students will have to create their own graphic novel of Newton's laws; illustrations and appropriate dialect. Because they will initially receive scaffolding, I think the students will feel more confident when completing the task.

### **Background Information for Teachers**

This section provides a brief background of the information an educator would need to be familiar with if the focus topics of this unit are being used. However, if other topics are being adapted to fit the format of the unit, the background information needed to teach the lessons will vary. Listed below is information I acquired about the topics before beginning the unit.

#### *The discovery of oxygen*

Joseph Priestly and Carl Wilhelm Scheele discovered oxygen at the same time in the 1770s. The fact that both men worked independently on the discovery is well known by some, but not by most 7<sup>th</sup> graders. Oxygen was initially called "fire air" by Scheele, and "dephlogisticated air".<sup>7</sup>

#### *The life of Isaac Newton*

Isaac Newton was born in Lincolnshire, England in 1642. When he was three years old, his mother left him to be raised by his grandmother. Newton never developed a close bond with his grandmother. As a child, he alarmed some of the townspeople with a few of his inventions. One night he flew a kite with a lit lantern attached to it.<sup>8</sup>

After grammar school, Newton was accepted into Trinity College in Cambridge. During that time the courses of study were mainly philosophy, religion, poetry, logic, and languages. Trinity acquired its first professor of mathematics, Isaac Barrow, in 1664. Newton took an interest in the teachings of Barrow and later became his protégé. Later, Newton himself became professor of geometry at Trinity College.

Newton was very interested in the motion, planets, the heavens, space, time, light, colors, and eternity. He studied books and documents written by other famous scientists and philosophers, such as Copernicus, Galileo, Kepler, Aristotle, and Descartes, to name a few. After building the first telescope that used mirrors instead of lenses, Newton presented his device to the Royal Society in London. The Society members elected him a member shortly after. He eventually became president of the Royal Society in 1704.

#### *Newton's Laws of Motion*

Although Isaac Newton is credited with authoring the three laws of motion, he used the works of other scientists and philosophers as his springboard. The work of Robert Hooke, Francis Bacon, Galileo Galilei, Rene Descartes, Aristotle, Nicolaus Copernicus, Kepler, Archimedes, and Aristarchus all inspired Newton in some manner, even if it was just too disprove the work. I became familiar with the works of these scientists and philosophers as they related to Newton's laws of motion in order to help guide my students through the wealth of information. This unit is aligned to the North Carolina Standard Course of Study for seventh grade language arts and science. The goals and objectives for the unit are presented in *Figure 1* of the appendix.

## **Activities**

Focus topic one: Scientific discovery can be ambiguous

### *Background Information*

I will begin the unit during the first quarter of the academic year by having the students read excerpts from the play *Oxygen* by Carl Djerassi and Roald Hoffmann. The play explores the controversy over which scientist first discovered the element oxygen, which scientist first understood its properties, and which of the two—discovery or understanding-- is more important. I chose this play because it is a perfect transition into my unit. During the first quarter of the school year, I cover atmosphere and weather with my students. They study the properties and the composition of the atmosphere. Oxygen is also the most known gas to 7th graders. Before the students begin reading the excerpts, I will explain the setting to them and a few words they may be unfamiliar with. The play actually takes place in 1777 and then in 2001. The scientists involved are Joseph Priestly, Antoine Lavoisier, and Carl Wilhelm Scheele. All three men played a role in the discovery and understanding of oxygen, also known as vital air and phlogiston, in the 18th century. However, each believes he alone should receive the credit. In 2001 a Nobel Prize committee wants to award a retro Nobel Prize to the scientist responsible for the discovery of oxygen, but who should receive the credit? The scientists also have significant others who play somewhat contrasting, but important roles in the play. Students will form opinions regarding the validity of recorded scientific discovery, and in groups they will discuss other issues surrounding scientific discovery.

### Lesson One

Materials: *Oxygen*: Carl Djerassi and Roald Hoffmann, c.2001, chart paper, copies of excerpts

Procedure: Begin this activity by asking students to tell you what they know about oxygen. After listening to several responses, ask students who discovered oxygen. This question will definitely be a conversation starter. Next, pass out the excerpts, and explain the setting. Write the words phlogiston, and oxygen on the board; making sure students realize the words are all synonymous. There are eleven roles in the excerpts so I will ask for eleven volunteers to read. They will read from pages 28- 32, then from pages 66-77. These are the sections in which the height of the controversy is discussed by the Nobel Prize committee, and by the scientists themselves. After reading the excerpts, I will place the students in groups of four to answer the following questions:

- Which scientist do you think should win the Nobel Prize for the discovery of oxygen?
- Is it important for us to know which scientist discovered it first?
- Why is it important for us to know who discovered it first?
- What role did the significant others play in the discovery and how did their roles contrast?
- What does this drama say about science?

After the students have had time (15 to 20 minutes) to discuss and write the answers within their groups, I will facilitate a class discussion based on these questions.

Focus topic two: The life of Isaac Newton- the man vs. the scientist

### *Background Information*

The next activity of the unit will focus on the life of Isaac Newton. I will start this at the beginning of the fourth academic quarter. Our state standards require the students to learn Newton's three laws of motion, but I think it is important to lay a foundation about Newton as a person. This is the element of "looking behind the mask". Many students only know the academic life of scientists, but many times their personal lives and values help shape their discoveries. My goal in this activity is to encourage students view scientists as multi-dimensional people and to maybe find some common ground between themselves and the scientists. This will be accomplished by analyzing Newton's personal and professional life, his character, and events that took place during the time period in which he lived. After this, I think the students will be more receptive to Newton's Laws of Motion.

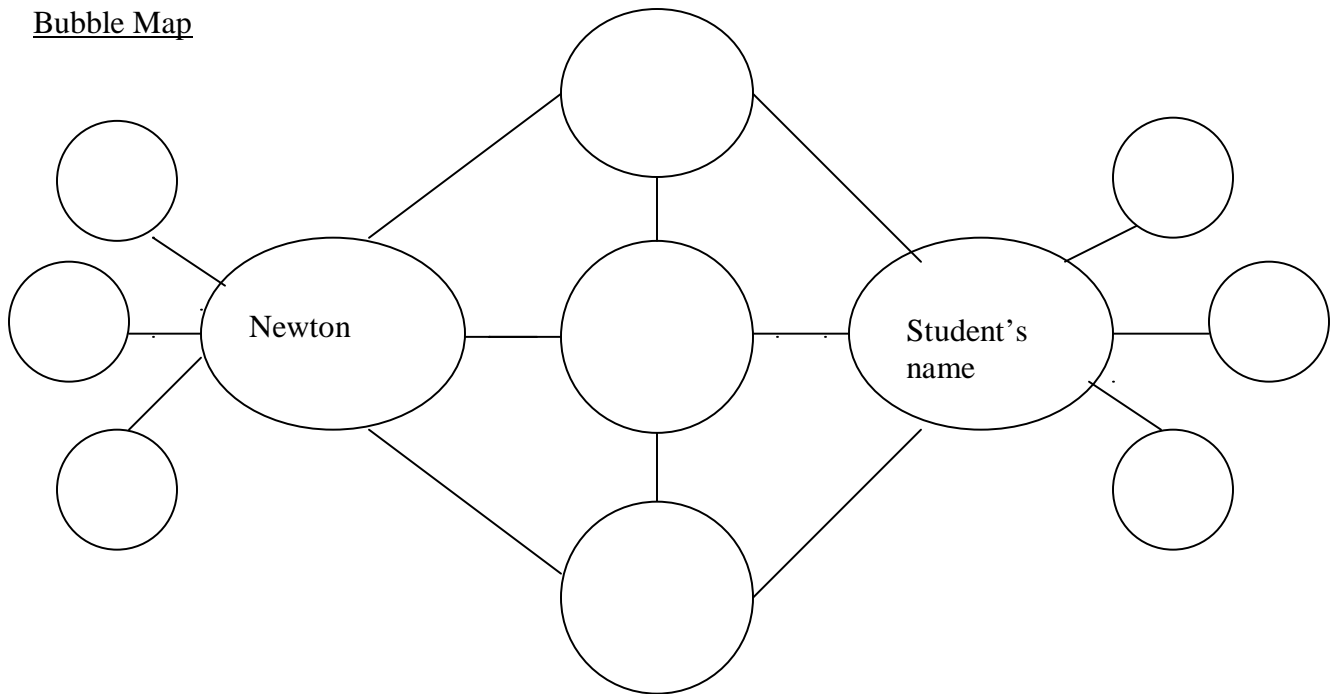
After evaluating the laws of motion using the textbook examples and some demonstrations, the student's mastery will be gauged. A graphic novel will be used to indicate their level of understanding of the laws. Many of the students I teach are artistically inclined, so the use and creation of a graphic novel in the lesson will definitely be a motivator.

Lesson Two

Materials: Isaac Newton (Giants of Science). Krull, Kathleen. New York City: Puffin, 2008  
writing journal or notebook

Procedure: The students will read the book Isaac Newton by Kathleen Krull. The book is written on a fifth-grade reading level, which will aid in the comprehension for some of my ESL (English as Second Language) students and my lower academic achievers. There are twelve chapters in the book. The students will read two chapters a day and complete an in class assignment after reading. After reading chapters one and two, each student will create a bubble map graphic organizer comparing and contrasting their life to that of young Isaac Newton. Ask students to think about and compare Newton's interests, upbringing, and challenges as child to their own experiences. Students will identify three similarities and write them in the three middle bubbles on the map. Then, students will identify differences and write them in the corresponding outer bubbles. The students will keep the mini-assignments in their notebook.

Bubble Map



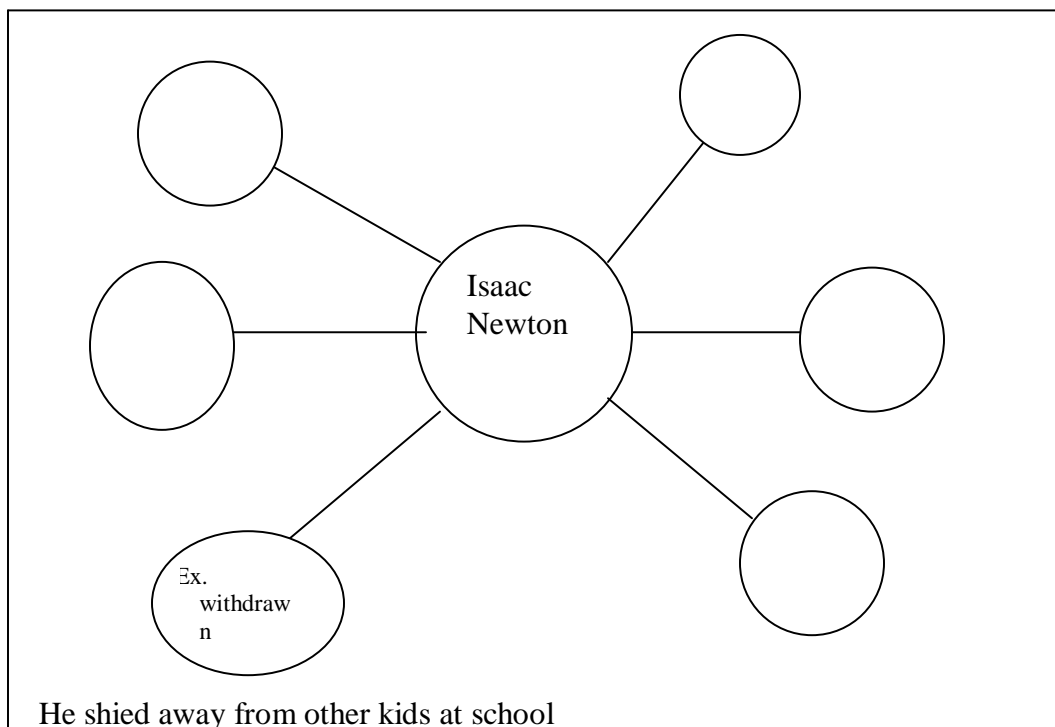
Following chapters three and four, students will complete another bubble map comparing and contrasting the Bubonic Plague of Newton's day and the Swine Flu (H1N1) of today.



This activity will allow students to peer ‘behind the mask’ of epidemics by comparing and contrasting the cause and effects and the contributing factors of Newton’s era and today.

After reading chapters five and six, the students will create a bubble map and fill it in with adjectives describing Newton. Students will draw a frame of reference around the Bubble Map, in which they will provide evidence to support a couple of the adjectives.

### Bubble Map and Frame of Reference



The culminating activity after reading this book will be writing a comparative analysis paper focusing on the similarities and differences between Isaac Newton “the person” and

themselves. Students will use the information in their writing journals to construct their paper.

Focus topic three: How many scientists does it take to make one discovery/ theory?

### *Background Information*

The activities that correspond to this focus topic will help students master the concept of Newton's laws of motion and encourage students to note that scientific knowledge and theories build upon each other. For most students, the laws of motion are similar to the preamble of the constitution of the United States of America- something to be read from the textbook, and memorized for tests. We are going to look behind the "mask" of these "lifeless" laws by using a graphic novel as the primary source.

Graphic novels are similar to comic strips, but the illustrations look different and they usually illustrate a storyline. This novel will definitely pique the interest of students because I have seen several creating graphic novels in their spare time. After mastering these concepts, I will ask students to think about the length of time it probably took Newton to derive his laws.

Most students believe a theory or discovery is made when a scientist goes into the laboratory one day and comes out with an idea. Students fail to take into account previous experiments and recorded data from other scientists that aid in these discoveries. After they have mastered the concepts behind Newton's Three Laws of Motion, I will ask my students to think about how Newton derived these laws. What prior knowledge was necessary? I will listen to the answers the students give, and hopefully one of them will mention the word 'gravity'.

Many scientists and philosophers who preceded Newton sought an understanding of the force. Their experiments and notes on the topic, correct and erroneous, served as the bases of Newton's Laws. The students will conduct research to find out how Newton arrived at his Laws of Motion. The students will synthesize and use information from a variety of sources in order to create a timeline displaying scientific and philosophical contributions to the discovery and understanding of gravity.

### Lesson Three

Materials: Class set of Isaac Newton and the Laws of Motion. By Andrea Gianopoulos.,  
Copies of page 21 from the book, package of white drawing paper, color pencils

Procedure: Write the following questions on the board or projector and instruct the students to copy them into their writing journals:

1. Describe Newton's first law of motion
2. What action in the book demonstrated this law?
3. Describe Newton's second law of motion
4. What action in the book demonstrated this law?
5. Describe Newton's third law of motion.
6. What action in the book demonstrated this law?

After copying the questions, the students will each receive a copy of the graphic novel. The book is divided into four short chapters. As the students finish a chapter, they will stop reading and answer the questions associated with the chapter they just read. This should take 20-25 minutes for most classes. Next, students will compare the answers to their questions with their neighbors'. Then, as a class we will discuss the answers. I will place the students in pairs and pass out a copy of page 21 (with some of the text removed) to each pair. Without using the book, the students will fill in the missing words so that the statement accurately explains the action in the picture. On the copy, the students will also write which law is being depicted. The length of time I spend on this part of the lesson will depend on how quickly the students grasp the concepts. For the second part of this lesson, the students will again be placed in pairs. Each pair will be given three sheets of white drawing paper. The students will create their own graphic novel of Newton's laws of motion (one law per sheet of paper), complete with illustrations and text. It will be up to each pair to decide how they want to divide the responsibility. I will suggest that if someone's strength is drawing, they create the illustrations, and the same applies for the strength of writing. I will instruct students to color their graphic novel after it is complete. My class periods are about 80 minutes long so they should finish the illustrations in a class period. After finishing their novels, the students will turn them in and I will grade them for accuracy.

#### Lesson Four

Materials: Internet access for students, cardstock, printer paper, markers, color pencils, glue sticks

Procedure: For this activity I will place the students in groups of three. I will then assign one of the following scientist or philosopher to each group: Robert Hooke, Francis Bacon, Galileo Galilei, Rene Descartes, Aristotle, Nicolaus Copernicus, Kepler, Aristarchus, and Archimedes. Each student in the group will have a different role. One student will be responsible for creating an illustration of their person. Another student will have to research their person's contribution to the discovery and understanding of gravity, noting any famous experiment. The third person in the group will be responsible for finding out how their person's works influenced Isaac Newton. I will take my students to the computer lab for one class period to research and print off anything needed to complete the activity. Each group will display each component of the research on an 8x10 piece of card stock. The illustration should take up no more than half the

page. The rest should be used for text. The students may choose to retype the researched information at home or write it neatly before attaching it to the cardstock. After all groups have completed and turned in their assignment, I will put them all on display in the classroom. I will display them as a complete a timeline dedicated to the discovery and understanding of gravity.

### Notes

<sup>1</sup>Amy Brualdi., "Multiple Intelligences: Gardner's Theory." (ERIC " Education Resources Information Center type in year) - Worlds™ largest digital library of education literature. <http://www.eric.ed.gov> (accessed October 24, 2009).

<sup>2</sup>Verna Eaton. "DIFFERENTIATED INSTRUCTION." University of Alberta - Edmonton, Alberta, Canada. <http://ualberta.ca/~jpdasddc/incl/difinst.htm>

<sup>3</sup>David Yeager and Chris Hyerle. "Thinking Maps A Language for Learning". (Cary: Thinking Maps, Incorporated, 2007), 2-8

<sup>4</sup>Ibid.

<sup>5</sup>Ibid., 8

<sup>6</sup>Education World ®: Curriculum: Teaching the American Revolution, "Scaffolding to Success," [http://www.education-world.com/a\\_curr/curr218.shtml](http://www.education-world.com/a_curr/curr218.shtml)

<sup>7</sup>Owen L. Shinn., "The Discovery of Oxygen," *Journal of The American Chemical Society* 16, no. 10 (1894), <http://ezproxy.lib.davidson.edu:2251/doi/abs/10.1021/ja02108a016?prevSearch=%255Btitle%253A%2Bdiscovery%2Bof%2Bxygen%255D&searchHistoryKey>

<sup>8</sup> Kathleen Krull, *Isaac Newton: Giants of Science* (New York City: Puffin, 2008) 24

## **Appendix**

### *Figure 1- North Carolina Standard Course of Study*

#### Language arts- Grade 7

Goal 1 The learner will use language to express individual perspectives in response to personal, social, cultural, and historical issues.

*Objective 1.02* Respond to expressive materials that are read, heard, and/or viewed by:  
-comparing and/or contrasting information  
-creating an artistic interpretation that connects self and/or society to the selection

*Objective 1.03* Interact in group settings by:  
-responding appropriately to comments and questions.  
-offering personal opinions confidently without dominating.  
-giving appropriate reasons that support opinions.

Goal 2 The learner will synthesize and use information from a variety of sources

*Objective 2.01* Respond to informational materials that are read, heard, and/or viewed by:  
-soliciting and respecting another person's opinion  
-summarizing information

Goal 5 The learner will respond to various genres using interpretive and evaluative processes.

*Objective 5.01* Increase fluency, comprehension, and insight through a meaningful and comprehensive literacy program by:  
-reading literature and other materials selected by the teacher  
-engaging in small group discussions

## Science

Goal 1 The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

*Objective 1.10* Analyze and evaluate information from a scientifically literate viewpoint by reading, hearing, and/or viewing:

- scientific text
- articles

Goal 6 The learner will conduct investigations, use models, simulations, and appropriate technologies and information systems to build an understanding of motion and forces.

*Objective 6.03* Evaluate motion in terms of Newton's Laws:

- for every action there is an equal and opposite reaction.
- the greater the force, the greater the change in motion.
- an object at rest will remain at rest

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### **Teacher Web Resources**

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