Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Animating a Nuclear Process

Curriculum Unit 12.04.04
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Objective

The students will apply previously acquired knowledge of the nuclear atom, quantum mechanics and the atom's subatomic architecture in order to further appreciate and conceptualize a nuclear process using stop motion animation.

This unit is more about motivating students who might not otherwise be motivated to learn a particular set of complex material. The goal of this unit is not so much to teach Nuclear Chemistry as it is to produce a sustainable creative tension within the student that drives him/her to ingest and process inherently difficult material. Furthermore, the student must synthesize new ideas related to this material whose byproduct serves as evidence of their learning.

Rationale

The National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science and Achieve are developing the framework for the Next Generation of Science Standards. It is in the spirit of this soon to be finalized national curricula set and standards set that this unit on Nuclear Processes is developed (see appendix A).

It is understood that American students are underperforming in science. According to the Programme for International Student Assessment (PISA) 2009 data, American students ranked 17th in science achievement globally. Our students will require a broad foundation of scientific skills and literacy in order to thrive in the 21st Century global economy. To this end, the current model of science curricula being developed stresses higher levels of science learning.

This unit is intended to extend the students' capacity for innovation and creativity as it stresses integration of problem solving analysis, problem solving skills, communication, imagination and productivity. In this unit, students are expected to manage a large volume of complex material, divide that material down into smaller more manageable modules and present a cohesive vision of their learning in the form of a stop motion animation. Students will develop their Science, Technology, Engineering, and Math (STEM) skills as they work with a partner to formulate, manage and develop, revise and edit new ideas. They will examine cause and effect relationships in nuclear chemistry so that they may bring their designs into being.

Introduction

New Haven Academy is a small inner city magnet high school (grades 9-12) in the New Haven Public School System serving approximately 250 students from the greater New Haven area. According to data released by the City of New Haven in its Fiscal Year Site Based Budget, more than two-thirds of our students qualify for free or reduced lunch which is a strong indication that New Haven Academy serves an impoverished population of students. The challenges of presenting coursework to a disadvantaged population of students are many. Evidence of the basic challenges of instruction can aptly be appreciated by the yearly student performance on Connecticut's 2011 Academic Performance Test (CAPT). New Haven Academy students pass the math component of the CAPT at a rate of 50.8%. Statewide, their peers pass at a rate of 80.3%. New Haven Academy facilities are antiquated and as such the science program and the chemistry course in particular, are restricted from offering a great number of laboratory activities. It is a challenge to overcome these difficulties and offer alternatives to many laboratory experiences typically offered in the high school experience.

Nuclear chemistry and nuclear processes are not tantamount in the consciousness of the ordinary New Haven Academy student. For this reason, this unit is designed to stimulate interest, push understanding and personalize their experience with this topic. This unit will feature a variety of instructional techniques, hands-on collaborative learning activities; structured class work and independent homework culminating in a stop motion animation project that will be a collaborative student centered learning process. Project assignments will be tailored to each student's ability. As Chemistry is a methodical subject that is highly ordered, students benefit greatly from a sequential presentation of material. There is no great allowance for flexibility in scheduling of the subject matter because the material is so hierarchical in nature. Consequently student engagement and interest are of the highest concern as the serial flow of information builds upon itself. Students who lose interest early in the academic year experience increasing difficulties and increasingly struggle with engagement as the year moves on. It is explicit goal of this unit to peak the New Haven Academy student's interest with an engaging unit on Nuclear Processes and Nuclear Chemistry.

Unit Description

The Animating a Nuclear Process Unit will follow units covering Scientific Measurement, the Periodic Table, Atomic and Molecular Structure, and Electron Configurations. All of these units provide necessary and required background knowledge for the successful completion this unit. Students embarking on this unit require an understanding of the basic architecture of the nuclear atom and the mass and charge of subatomic particles. Students require specific knowledge of the periodic table in order to determine the number of protons in an atom's nucleus. Students need to recognize that atoms exist in various forms called isotopes and must already have the capacity to distinguish between such concepts as the average atomic mass and the mass number of an atom. Students must also recognize, prior to the advent of this unit, that particles of opposite charge attract one another. Finally, it is expected that students have already acquired a basic set of math skills that will permit them to calculate percentages and graph a data set on a coordinate plane.

While there is a lot of information front loaded in this unit, it does not detract from the students having to explore a number of essential questions. These questions include, but are not limited to; what is radioactivity? what makes something radioactive? how is half-life determined? how do radioactive emissions occur? what are radioactive particles? what does it mean for an element to transmutate? what is fission? what is fusion? how does nuclear chemistry impact our lives? is nuclear chemistry dangerous? is nuclear chemistry beneficial? what are the hazards associated with living near a nuclear power plant? what are the hazards associated with living near a nuclear waste storage facility? what are the applications of nuclear chemistry in medicine? how does a nuclear weapon generate so much destructive force?

The Animating a Nuclear Process Unit will run approximately six weeks in length. The first three weeks will be spent meeting standard curricula objectives and State of Connecticut Science Standards. The second half of the unit will be spent in an animation lab planning, producing and editing animations, thereby aspiring to the Next Generation of Science Standards (national curricula).

Part 1: Meeting Connecticut Science Standards

Students will be given a reading list and a time-line to complete their reading. The students will receive explicit instruction on how to outline their reading and record important points. In order to support student learning, students will be given direct instruction on this material in the form of lectures, question and answer sessions, a variety of hands on activities intended to reinforce concepts such as measuring and graphing radioactive decay rates of a fictional element and will be given in class and homework assignments intended to develop problem solving skills related Nuclear Chemistry. These activities serve as a mechanism to monitor student understanding.

Assessments will be frequent during this period of instruction. Students will benefit from immediate feedback on their daily performance. Electronic response pads allow for immediate feedback and facilitate pacing and movement through what can be considered dense material. In the absence of response pads, students can be given frequent quizzes of which not all are collected and graded by the teacher. These quizzes can be self-assessed in the moments immediately following administration. While some quizzes can be assessed in this manner, others must be collected and graded by the teacher as well. In either case (electronic response pad or varying student/teacher graded quizzes), the goal is to create and maintain tension in and out of the classroom while generating a sense of excitement and engagement with the material. Struggling students will be identified early and often and should be provided extra support from a variety of sources (the instructor, paraprofessionals, resource teachers, after school office hours and peer tutoring programs).

Personal responsibility and independent engagement with the material will be supported by such mechanisms as open note quizzes. For the examination at the end of the first half of this unit, students will not have access to any supportive material or aids. Students will be given access to practice tests during the final preparation period before administration of the final examination on this material for purposes of self-assessment.

By the end of the first half of this unit, students will be able to:

1. Explain how repulsion forces (proton-proton) are overcome in the nucleus
2. Relate the energy liberated during a nuclear process to its change in mass ($E=mc^2$)
3. Illustrate how unstable parent isotopes decay to more stable daughter isotopes
4. Distinguish between the three most common forms of radioactive decay (alpha, beta and gamma) and recognize how the nucleus of the atom changes as a result
5. Explain the different kinds of damage in matter that results from exposure to each kind of radiation (and the relative penetrations)
6. Calculate the amount of radioactive substance remaining after a given number of half-lives has transpired

Unit Vocabulary

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alpha particle
band of stability
beta particle
film badge
fission
fusion
gamma ray
Geiger counter
half-life
ionizing radiation
neutron absorption

neutron activation
analysis
neutron moderation
nuclear force
positron
radiation
radioactivity
radioisotopes
scintillation counter
transmutation
transuranium elements

By the end of the second half of this unit, students will demonstrate proficiency in:

1. Planning a large project
2. Performing research on a given nuclear process topic
3. Collaborating with a peer to plan and design an original instructional animation detailing a nuclear chemistry process as its centerpiece
4. Executing said plan
5. Revising and editing

Unit Strategies

Introduction

The first half of this unit will be an exploration of the major topics and themes of Nuclear Chemistry. In keeping with the sequential nature of chemistry, and nuclear chemistry being no different, our studies will follow a very orderly path.

Historical Perspective

The class will begin its studies on Nuclear Radiation, after having already examined the work of J.J. Thomson, Ernest Rutherford and Henri Becquerel, with a brief exploration of the life and work of Madame Marie Curie who, in 1911, was awarded the Nobel Prize in Chemistry for her work studying radioactive elements. Madame Curie is credited with furthering our understanding of radioactive materials. Sadly, her very life and death informed us of the risks associated with long term exposure to said materials. Marie Curie died in 1934 from Leukemia as a result of her work and exposure to radiation. We will continue exploring the history of Nuclear Physics by studying the work of Viennese born Lise Meitner and Otto Hahn.

Radiation

In this section of the unit, the class will study the mechanisms of discovery and the discoveries of Madame Curie; that radioactive materials "fogged" radioactive plates when exposed.

The unit plan is to introduce the concept of radioactive decay and the three main types of radioactive decay; alpha decay, beta decay and gamma radiation. In keeping with an already established tenet of science and this course, the Law of Conservation of Mass, we will write and track all particles associated with these types of emissions.

Examples:

$$ {}^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He} $$

Uranium-238	Thorium-234	alpha particle (α emission)

Alpha Radiation

$$ {}^{234}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa} + {}^{0}_{-1}\mathrm{e} $$

Thorium-234	Palladium-234	beta particle (β emission; electron)

Beta Radiation

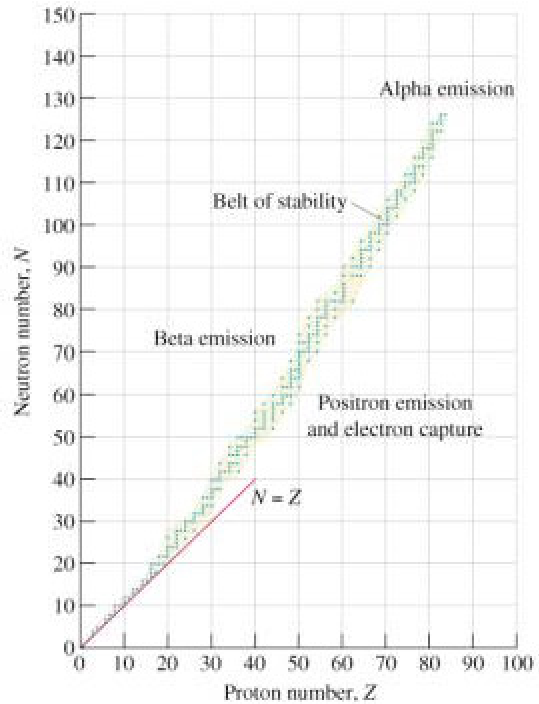
$$ {}^{40}_{18}\mathrm{Ar} \rightarrow {}^{40}_{18}\mathrm{Ar} + \gamma $$

Argon-40 (excited)	Argon-40	gamma radiation (photon)

Gamma Radiation

Nuclear Transmutations

We will then discuss transformations that occur as a result of nuclear decay. The attractive force, known as nuclear force, that is present to overcome proton-proton repulsive forces is sometimes insufficient to keep a nucleus intact. This event follows a fairly predictable pattern and can be appreciated quantitatively in a plot graph known as the **band of stability** , a concept that Lise Meitner intuited and paired to Einstein's mass-energy equivalence ($E=mc^2$).



What happens to atoms when the nuclear force is overcome? In this section we will further explore the decay processes that result and put these processes into the context of a decay curve for various radioactive materials (a half-life curve).

Energy Yields in Fission and Fusion Reactions

We then explore the energy yields and circumstances under which fission and fusion reactions occur both naturally and as man-made events. Students compare and contrast fission and fusion reactions.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + ^{1}_{0}n + ^{1}_{0}n + ^{1}_{0}n + ENERGY$$

Uranium-235 neutron Barium-141 Krypton-92 3 x neutrons (high energy)

Fission Reaction

Fission reactions occur in such places as a nuclear reactor and a nuclear bomb. Students will compare and contrast the kinds of chain reactions that are controlled in a nuclear reactor and how chain reactions are uncontrolled in an atomic bomb explosion.

In addition to large energy yields, these processes yield nuclear waste which is a significantly hazardous material. Keeping these materials sequestered in the short and long term represents a significant engineering challenge to say nothing of the social and political implications of maintaining the integrity of that engineering feat.

$$ {}^{1}_{1}H + {}^{1}_{1}H + {}^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{4}_{2}He + {}^{0}_{+1}e + {}^{0}_{+1}e + \text{ENERGY} $$

hydrogen nuclei   Helium nucleus   positrons

Fusion Reaction

Without nuclear fusion, life of as we know it could not be possible on Earth. The energy yields by our sun are experienced here on earth, some 96,000,000 miles away.

Practical Applications and Uses of Nuclear Materials

In this section we study the tools of the nuclear chemistry trade and applications of these materials in medicine. The circumstances surrounding Madame Curie's life and death provide ample and stark evidence as to the danger of being exposed to radioactive materials. These materials, however, are not without benefit. In this section students explore methods for detecting radiation exposure, applications of radioisotopes in medicine as diagnostic tools and as treatment for some diseases.

Part 2: Meeting the Next Generation of Science Standards (Animation Component)

Animating a Nuclear Process

In the second half of this unit, students will be assigned a partner. Partners will be matched by ability and mastery of the above material as determined by the strength of their individual performances on a given set of assessments.

On occasion there are benefits to combining high performing students with low performing students on project based work (like this animation project). The desired outcome of such a pairing is that the two students will form a symbiotic relationship as they engage the material together. Unfortunately, this pairing does not always yield the intended result. Frequently, the result is a dynamic where the lower performing student takes on a more passive role while the advanced student covertly manages the perceived risk of working with said lower performing student. In order to mitigate these risks and push all students to capacity, students will be paired by performances on the assessments given in the first half of this unit. Student pairings who have excelled on those assessments will receive an animation project assignment of greater depth and complexity. Student groups that struggled on those assessments will receive animation assignments of lesser complexity that focus on more fundamental nuclear processes.

Students will be paired by ability as demonstrated on previous unit component. Throughout the year students work in small groups and collaborate on a great number and variety of classroom activities. For this component of this assignment, students will be paired by aptitude for the material as indicated by their performances in the first half of this unit.

Students will work in an animation lab of this instructor's design for the remainder of the unit (approximately 3 weeks). Each set of two students will work at a personal computer with the following resources:

1. Microsoft Office (word processing software being the most relevant)
2. Internet access
3. Access to the Google Application MindMeister Mind Mapping by MeisterLabs for project planning (provided at no cost to the student and no additional cost the students in the New Haven Public School System).
4. SAM Animation software (licenses for 10 computers - $250)
5. Low cost web-cameras (approximately $109.50 will supply 10 computers)
6. 14 recycled, antiquated computers obtained from the school's media department yielding 10 functional computers for the lab (no cost).
7. Animation materials purchased (nominal cost)
   a. Clay
   b. Beads
   c. Makeshift melamine boards to serve as small white boards
   d. White board markers
   e. students will be encouraged to salvage and use any materials available to them being limited only by their imagination
8. Access to the New Haven Academy Library and the New Haven Public Library

Day 1 in the animation lab

The first day in the animation lab students will be paired with their partners. Students will then have some fun and become familiar with the animation software (SAM Animation) and hardware. Students will be given a short period of time to animate anything of their choosing and are given only two parameters:

1. 30 minutes to complete their animation
2. Students must make an animation that loops. That is to say, the first and last frame of this exploratory animation should be identical so that when the animation is played on a continuous loop, it will be cyclical and appear to have no beginning or end.

The purpose of supplying students with parameters is to develop creative tension, a sense of camaraderie with their partners, and to maximize the learning curve with this technology by encouraging students to take risks with their choices.

The final 30 minutes of this block period would entail a gallery presentation of student work. In this way, students will receive immediate feedback on their efforts; have an opportunity to see what their peer groups were capable of, and to see first-hand the creative potential for what will be this unit's showpiece assignment (animating a nuclear process).

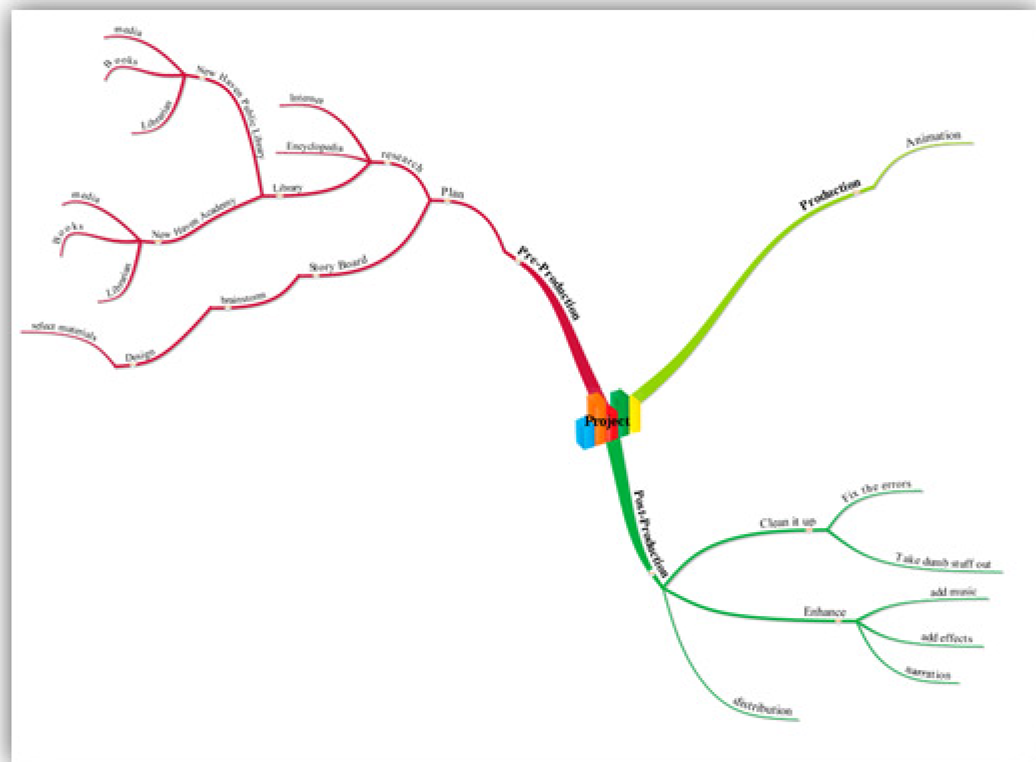
Day 2 in the animation lab - Project Assignments and Initial Planning

Each partner set will be given their project assignments. This portion of the unit is intended to be a fully collaborative student centered learning process. For this reason, the assignments are given as little more than titles. Students partnerships decide from start to finish what their final project will look like. Here is an example list of assignments.

1. Nuclear Reactor
2. The Sun as a Nuclear Reactor
3. Atomic Bomb
4. Fission Reaction
5. Fusion Reaction
6. Alpha decay
7. Beta Decay
8. Radioactive Decay and Half-lives

Assignments near the top of the list are more complex and are reserved for student groups that had excelled in the first half of this unit. The assignments become less complex further down the list. In some ways, the more fundamental assignments in this list have a greater potential for creativity because they are less complex and offer greater latitude of expression. This arrangement serves to accommodate learners at all levels.

Student pairs, at this point, are seated at their assigned personal computer stations and will work there for the remainder of the unit. Students will be introduced to **MindMeister Mind Mapping** software by engaging in an initial planning session. The initial planning stage will be a class discussion on how to modularize this large project. The initial plans will serve as the seed for planning their designs. The initial planning phase will be mind-mapped by each student group (as the teacher facilitates the discussion and demonstrates the software on an overhead projector).



At this point, the project rubric is handed out to all students. Scores (1-4) are given for the following categories (greater detail found in the appendix):

1. Planning/Storyboarding/Mindmapping
2. Sets and props
3. Organization: clarity of topic presentation
4. Animation: Originality and Creativity
5. Animation: pacing (frame speeds and timing and integration of components)
6. Use of class time and team work (monitored throughout project)

The remainder of the class period, and the remainder of the unit for that matter, is entirely student centered and focused on development of their respective projects. From this point forward, the teacher fades into the background and allows students to take responsibility for their learning. The role of the teacher, at this point, is to be present, to provide technical support, to monitor student progress, to function as a sounding board for student ideas, and to not interfere.

Day 3-9 in the animation lab

Students will spend one to one and one half weeks researching, brainstorming, planning and recording their plans in the mind mapping software. Students will an additional spend 1-1½ weeks animating their assigned nuclear process using SAM animation software. SAM animation software was developed by Tufts University Center for Engineering Education and Outreach (http://ceeo.tufts.edu/) and is marketed by iCreate to Educate (http://icreatetoeducate.com/). Students will spend ½ - 1 week in post-production editing and refining their animation work with music, narration and scene deletion/addition.

Students will submit their animation to be assessed along with their mind maps and appropriate citations of sources used.

Sources

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1. Next Generation Science Standards for Today's Students and Tomorrow's Workforce,

http://www.nextgenscience.org/

2. New Haven Public Schools Fiscal Year 2011-2012 Draft Site Based Budget

John DeStefano, Jr., Mayor

Dr. Reginald Mayo, Superintendent of Schools

Board of Education Members:

Dr. Carlos Antonio Torre, President, Susan R. Samuels, Elizabeth Torres,

Michael R. Nast, Ferdinand Risco, Jr., Dr. Selase Williams, Alex Johnston

3. Modern nuclear chemistry

By: Walter D. Loveland, David J. Morrissey, Glenn T. Seaborg

Publisher: Hoboken, N.J. : Wiley-Interscience, c2006.

Pub. Date: 2006

ISBN: 9781615838394

4. The Animator's Reference Book

By: Les Pardew; Ross S. Wolfley

Publisher: Course Technology PTR

Pub. Date: January 01, 2005

ISBN-10: 1-59200-675-2

ISBN-13: 978-1-59200-675-5

Appendix A: *Next Generation Science Standards (National Draft, May 2012)*

The performance expectations below were developed using the following elements from the NRC document A Framework for K-12 Science Education:

HS.PS-NP Nuclear Processes

Students who demonstrate understanding can:

a. Construct models to explain changes in nuclear energies during the processes of fission, fusion, and radioactive decay and the nuclear interactions that determine nuclear stability. [Assessment Boundary: Models to exclude mathematical representations. Radioactive decays limited to alpha, beta, and gamma.]
b. Analyze and interpret data sets to determine the age of samples (rocks, organic material) using the mathematical model of radioactive decay. [Assessment Boundary: Mathematical model limited to graphical representations.]
c. Ask questions and make claims about the relative merits of nuclear processes compared to other types of energy production. [Clarification Statement: Students are given data about energy production methods, such as burning coal versus using nuclear reactors.] [Assessment Boundary: Students only analyze data provided. Merits only include economic, safety, and environmental]

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 9-12 builds from grades K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and explanatory models and simulations.

Â· Ask questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. (c)

Developing and Using Models

Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world.

- Construct, revise, and use models to predict and explain relationships between systems and their components. (a)

Analyzing and Interpreting Data

Analyzing data in 9-12 builds on K-8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Use tools, technologies, and models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. (b),(c)

Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Students also use and create simple computational simulations based on mathematical models of basic assumptions.

- Use statistical and mathematical techniques and structure data (e.g., displays, tables, and graphs) to find regularities, patterns (e.g., fitting mathematical curves to data), and relationships in data. (b)

Score Levels	Planning/ Storyboard/Mindmap	Sets/Props	Organization of Content: Clarity/Neatness	Animation: Creativity and Originality	Animation: Frame Speed/Timing	Use of Class Time/ Team Work
4	• Storyboard/Mind map detailed and very easy to read and follow. • Much planning is apparent, with regards to background preparation, assigning tasks (if working in groups), and/or other aspects of pre-animation production.	• Sets/Props are exceptionally designed and cleverly communicate the concept of the animation. • Sets/Props are superbly intuitive, visually stimulating, and imaginative creating a sense of realism. • Much thought, time, and attention in the finest details is evident and ultimately enhances the overall animation.	• All content is logical, intuitive, and expressed through student's own words. • Subject knowledge is evident throughout and all information is accurate, appropriate, and clear. • Student uses interesting sequence of scenes and actions. • Entire animation is clear from beginning to end.	• Creativity is evident in the use of ideas, applications, and/or different materials used. • Animation is fresh, original, inventive, and captures audience's attention. • Student also incorporated excellent usage of audio features such as sound effects and/or music.	• The overall animation/frame speed is very well paced to enable clear viewing. • Completes the project well in advance of the allowed class time.	• Excellent use of class period. • Student stayed focused working without any reminders from the teacher to keep on track. • Team members are treated with respect. Members listen to all ideas. The work of each student is acknowledged.
3	• Storyboard/Mind map is mostly easy to read and follow. • A reasonable amount of planning is evident however some essential elements were not presented prior to animation.	• Sets/Props are well designed and communicate the concept of the animation well. • Sets/Props are visually stimulating and help create a sense of realism to the animation. • Good amount of thought, time, and attention to details is evident and help to enhance the animation.	• Almost all content is in student's own words and requires few corrections. • Subject knowledge is evident in much of the animation and information is accurate, appropriate, and clear. • Most scenes and actions are presented in a logical manner. • Storyline is easily followed throughout animation.	• There is some evidence of creativity in some of the ideas but not consistent throughout animation. • Good use of originality and inventiveness. • Animation offers new insights and captures audience's attention.	• The animation is good, though frame speeds seem to either drag on OR need to be slightly longer to address. • Completes the project within the class time allowed.	• Used time well during the class period. • No reminders needed, as observed by the teacher. • Team members have respect for each other but some members may not be heard as much as others. The work of each student is fairly acknowledged.
2	• Storyboard/Mind map is too general. • Little planning is evident. More detail is required before animation can be carried out effectively.	• Sets/Props lack creative design and provide little value to the animation. • Sets/Props provide minimal visual stimulation and do not compliment the animation. • Not enough thought, time, and/or attention to detail is evident.	• Less than half of the content is in student's own words and requires many corrections. • Some subject knowledge is evident however some information is confusing, incorrect, or flawed. • Some logic to the sequence of scenes and actions are evident but not easily followed throughout animation.	• Creativity is lacking as it is evident that student took the quickest and easiest route in creating the animation. • There is little evidence of thought or inventiveness. Animation does not capture audience.	• The animation seems to be in need of more editing on frame speed. • Student rushes to complete the project within the class time allowed.	• Used time well during most of the class period. • A few reminders needed to get back on track. • The team atmosphere is competitive and individualistic rather than cooperative and supportive.
1	• Storyboard/Mind map is inadequate and lacks much needed details. • Little to no planning is apparent.	• Sets/Props are very poorly designed and provide no value to the animation. • Sets/Props lack any visual interest and/or appeal.	• The content is clearly not of the student's own words and more than half of the animation needs corrections. • Subject knowledge is not evident as information is confusing, in-correct, and flawed continuously throughout animation. • There is no logical sequence.	• No use of creative concepts present in animation. • No evidence of new thought and lacked any signs of inventiveness. • Animation appears sloppy and/or unfinished.	• The animation lacks consistency between frames • Student is not able to complete project within the class time allowed.	• Did not use class time well. • Needed frequent reminders by the teacher to get back on track. • There is no sense of team within the group.