Title: A study on the impact of incorporating Biotechnological labs and activities in the AP Biology Curriculum and how it affects student learning gains and attitude towards Biotechnology.

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Abstract:
Within the past few years there has been a movement towards incorporating Biotechnology in our secondary schools. Some schools adopt biotech programs, in the form of Career and Technical Education (CTE) or Science, Technology, Engineering, Mathematics (STEM) programs. However, most schools are infusing the biotechnology curriculum within the Biology courses. Unfortunately, while there is a demand to teach biotechnology, many schools are not investing in this initiative. Many teachers are not trained in the current trends in biotechnology, nor are schools expanding their budgets to accommodate any costs of biotechnological activities.

This action research study will analyze the use of hands-on/interactive biotechnological activities in the Biology classroom and their impact on student knowledge and attitudes towards biotechnology, specifically DNA and its use in genetic screening. The research will be measured using state standard-based comprehension pre and post-tests. The students will also complete self-reporting surveys which will assess their comfort with biotechnological concepts, ethics and skills.

Rationale:
"Incorporation of biotechnology into the school curriculum is a necessity if this most recent and promising technology is to achieve its maximum potential through intelligent decision making" (Zeller, 1994)

It was through many studies similar to the aforementioned that the initiative was made to incorporate biotechnology into secondary education curriculum. Our students need to recognize and understand buzzwords such as gene cloning, genetic engineering, gene splicing, recombinant DNA, gene therapy, genetic screening and the human genome. Over 95% of students graduating from high school have taken biology, so it is the best method to incorporate biotechnology curriculum. (Zeller, 1994)

However many biology "teachers are concerned as to where such units will fit in an already overcrowded list of course objectives" (Zeller, 1994). In another study, it showed that many teachers are "implementing biotechnology topics (96%), but not equipment (4%). Teachers complain that it is too time consuming, expensive and does not fit into their state core curriculum." (Bigler & Hanegan, 2011) Despite their efforts, they are missing a key component, without the equipment, they cannot teach hands-on. "Biotechnology is a topic of study that requires hand-on learning in order to fully learn and understand." (Bigler & Hanegan, 2011) There is an agreement of a minimum amount of information high school graduates should have: at minimum a conceptual knowledge of the molecules of life, the central dogma (DNA→ RNA→protein) which is the basis for the construction of all living matter. This basis of

knowledge will allow for students to understand modern technologies, and possibly enter this progressive field. (Zeller, 1994). When implementing the various topics into the biology course, bioethics, biotechnology in agriculture and medicine should be a priority and surprisingly DNA fingerprinting and genomic library least of importance. It is also suggested that 20 days, 4 weeks would be best to teach genetics/biotechnology. Presently teachers dedicate 10 days, with an average of 1- 4 labs. (Zeller, 1994)

Dedicating 20 days would be difficult for most if not all biology classroom teachers. To help teachers there was a study completed in which a traditional school implemented their biotechnology curriculum, for 20 school days, and another school, implemented the curriculum however with biotechnology hands-on activities for 13 days. "As a suggestive relationship was shown that the biotechnology intervention school had a larger increase of student content knowledge than the traditional learning school ($p = 0.0543$), it is suggested that less time is needed to teach genetics concepts by implementing biotechnology equipment" (Bigler & Hanegan, 2011)

Last year I was one of those teachers who taught the AP biology unit on genetics/biotechnology in about 10-15 days, and did 2 activities with them (central dogma Ice cream synthesis lab and Restriction Fragment Length Polymorphisms (RFLPs) DNA fingerprinting lab but on paper) and no wet labs. I came to Bench 2 Bedside for that reason, to gain biotechnological skills and activities that I can bring back to my students. I want to be able to teach them the mandated and current biotechnology skills in a manageable, convenient amount of time. I also want to get them excited about biotechnology, instead of being overwhelmed by how abstract it all is. I want to introduce them to this growing field, maybe it will guide their future college major, lead them to a promising career or at minimum they become an informed member of society.

The next challenge is to determine how to teach the students the material. Surveys of students and teachers were taken to determine the best instructional method for biotechnology. After a review of the responses, participants favored primarily lecture/discussion, followed by student labs and audiovisual presentations (Zeller, 1994). This can be seen in our current student body. Many of them cannot self-teach, consequently they become very frustrated. Furthermore, many of them do not learn and retain from lecture, but need some form of teacher lead discussion and lesson. Lastly, most importantly, the students need hands-on activities, which are ''educational experiences that actively involves people in manipulating objects to gain knowledge or understanding'' (Bigler & Hanegan, 2011).

However, methodology is not the only barrier for an educator, students must gain interest in the topic. For most students, this will be their first exposure to biotechnological concepts, and it may be overwhelming for them. A study determined "Knowledge was also positively correlated with interest ($r = 0.43$, $n = 698$, $P < 0.001$) and importance ($r = 0.29$, $n = 698$, $P < 0.001$), and these dimensions were correlated with each other." (Fonseca, Costa, Lencastre & Tavares, 2012). Due to those findings it is imperative that I am able to show the students the importance of biotechnology, which will help in their gain of knowledge, as well as gain their interest.

Another study, took qualitative data via student and teacher interviews to see if they gained interest in biotechnology through their hands-on activities here are examples of their feedback: "Student2 : I enjoyed actually doing it, instead of watching how to do it. Student3 : I learn way more if I do things myself. Student4 : When we're actually doing, it's like ''Oh, so this is what that means.'' Student5 : Yeah, it's kind of hard to imagine all this stuff." The study also "had evidence from the student interviews that those who were interested in the intervention learned more." (Bigler & Hanegan, 2011).

This plethora of evidence demonstrates why I plan to design and implement an action research plan that will teach biology students biotechnology skills and concepts via hands-on activities, which in turn will promote their attitude and learning gains.

Description of teaching unit or module(s), including expected outcomes

Chapter 13 Meiosis and Sexual Life Cycles	Teach prior to action proposal, short lecture, comparison/contrast with mitosis
Chapter 14 Mendel and the Gene Idea	Teach Mendellian genetics/recombinant frequency/chi-square/non mendellian genetics/
Action Proposal: Pre-test 30 MC Questions and Pre-Survey DAY 1 Hwk: Guided textbook notes for DNA structure/history	
Chapter 15/16 DAY 2	History Disovery of DNA Video from HHMI-timeline/guided textbook notes(DNA structure/replication). TBL on DNA structure/history. **Manipulative:** Model of Origin of replication large- different proteins place where they go. Hwk Bozeman Videos, with guided Notes
Chapter 17 Protein Synthesis DAY 3	Central Dogma- Initiation/elongation /termination short lecture **Manipulative:** Science Take Out DNA to Protein Parts A/B
Gene Mutations DAY 4	Mutations, types, **Manipulative** Science Take out DNA to Protein Part C
Hereditary Diseases DAY 5	Gene is DNA sequence/Mutations/Enzymes **Manipulative:** BLAST activity, given DNA sequence, find type of mutation, genetic disease and information about the disease.
POMPE Discussion DAY 6	Gene Mutation Looking through a Father's Eyes
POMPE Road to Treatment DAY 7	Biotech ERT **Manipulative:** Timeline activity- understand clinical trials, ERT/enzyme replacement therapy
POMPE Putting it all Together "Clinical Laboratory Protocal" DAY 8	Central Dogma/ Bio Tech Assay **Wet Lab /Manipulative /Biotech Acid Alpha-Glucosidase Activity Assay**
Prep for Nature's Dice DAY 9	Gel Electrophoresis/DNA fingerprinting via paper RFLPs activity
Modes of Inheritance DAY 10	Genetic Screening, Gel Electrophoresis, Pedigree, Genes, Inheritance Mendellian genetics **Wet Lab/Manipulative/ Biotech:** Nature's Dice Genetic Screening/Gel Electrophoresis
DAY 11 Day to Review, finish Labs , discussion	
Post Test/ Post Surveys Day 12	
Control of Gene Expression	Guided Notes- POGIL (Process Oriented Guided Inquiry Learning) Control of Gene Expression
Transformation	Tentative C. elegans Lab or Bacterial Transformation

Blue=Concepts I expect to be mastered **Orange= Equipment Locker Needed**

Data collection techniques and/or student assessments:
Data will be collected via the use of qualitative and quantitative analysis. A multiple choice assessment will be created using 30 state standard based questions. This assessment will be given as the pre-test and post-test. The results will be analyzed to determine student learning gains.

A self-reporting likert-type (1=strongly disagree to 5=strongly agree) instrument composed of 20 questions will serve as one approach to collect qualitative data. The likert form will help analyze interest in science classes and activities, confidence in ability to perform biotechnology tasks, attitude towards biotechnology concepts and ethical topics (Wood, Knezek & Christenson, 2010). I will also adopt the likert-survey from the hands-on intervention survey which consisted of 40 questions on a scale of completely true to completely false (Bigler & Hanegan, 2011)

Lastly, students will be asked a short list of open ended, interview questions. Some questions will ask if they have ever taken AP or STEM courses before. Another question will be if they feel the hands-on activities supported their learning? If participating in the various activities did they gain an interest in biotechnology, if so, how so?

B2B summer institute elements specifically included (UF connections)
The activities that I will be using were presented to us during the 2 week Bench 2 Bedside summer institute are the following:

- Science take –out activity : DNA to Protein
- Blast Activity – Identifying disease genes
- Modes of Inheritance (Nature's Dice): A Genetic Screening
- Pompe: A look through his father's eyes jigsaw, Pompe timeline, Pompe put it all together GAA.
- UF Connections: Locker for Science take-out activity, nature's dice, and gel electrophoresis.

New Pedagogies:
Under the action proposal I have changed how I teach the genetics unit immensely. I am incorporating TBL, to assist in less lecture, teacher centered class structure. The object is to use the TBL to help in teaching the students the most important topics, assess them in their comprehension; then use a hands-on activity to re-teach/ensure their gain of knowledge. I normally would have lectured, and given practice worksheets (POGIL and general practice).

Another difference in my pedagogy is the use of more manipulatives. I am trying to have manipulatives for each lesson. I have a manipulative for teaching DNA replication (adopted from the Cell Cycle activity we did in Bench 2 Bedside), I would usually lecture with guided notes. I also have a manipulative to teach the Central Dogma, the DNA to Protein Science take-out lab, which I would normally do worksheets, and friendly competition practice of transcription/translation between student pairs. I will miss the friendly competition, but I think they will benefit from the hands-on manipulative. If time permits, I may have them compete.

I am also having the students use BLAST, which I have never done in the past. Typically when I teach mutations it is presented on one slide of types, and several examples given to them, for them to memorize. I am adopting this activity because BLAST will get them to see how a gene, a DNA sequence does mean something, and in this case it is the mutations which leads to an inheritable disease. So the change includes manipulative, but real life application as well.

Lastly, the inclusion of the assay and gel electrophoresis are techniques I have never used in the classroom. It is imperative that if I am going to teach biotechnology that I start having them DO biotechnology. I am excited for the POMPE activity and Nature's Dice. The discussions are what I look forward to the most. In the past, I have done a mock gel electrophoresis poster size, I am considering on still using it, the day prior to the real gel electrophoresis. It really helps with their understanding of what the restriction enzyme is doing and what gel electrophoresis is really doing. Sometimes doing gel electrophoresis alone can be "cool" but lack the understanding.

Literature cited:

Fonseca, M. J., Costa, P., Lencastre, L., & Tavares, F. (2012). Multidimensional analysis of high-school students' perceptions about biotechnology. Journal Of Biological Education (Routledge), 46(3), 129-139. doi:10.1080/00219266.2011.634019

Özel, M., Erdoğan, M., Uşak, M., & Prokop, P. (2009). High School Students' Knowledge and Attitudes Regarding Biotechnology Applications. Educational Sciences: Theory & Practice, 9(1), 321-328.

Tyler-Wood, Tandra, Knezek, G. & Christenson, R. (2010) Instruments for Assessing Interest in STEM Content and Careers. Journal of Technology and Teacher Education 18(2), 341-363

Zeller, M. F. (1994). Biotechnology in the high school biology curriculum: The future is here!. American Biology Teacher (National Association Of Biology Teachers), 56(8), 460.

Budget and budget justification

Vendor	Item	Pricing
Science Take-Out	From DNA to Protein	Qty 8 @ 8.00 each = 64.00
Carolina	Nature's Dice-Auto. Recessive	Qty 1 classroom kit = 310.00
Carolina (if can't use fast kits from CPET)	Agarose Melt and Pour 400ml	Qty 1 = 31.75
Carolina (if can't use fast kits from CPET)	Tris-Borate-EDTA (TBE) Buffer, 150mL	Qty 1 = 15.50
Carolina	Micropipet Tips, Yellow, Non-Sterile, 1-200 µL, Case of 960	Qty 1 = 75.00
CPET	Glucosidase Activity Assay	Equipment Request
		Total $ 496.25

SINGLE LESSON PLAN

Teacher: Ms. Shavon M Brookman	Content Area/Grade: AP Biology/ 9-12	Date: 6/25/15

Unit Name: Genetics

Unit Goal
What unit goal does this daily lesson address?

Genetics, is understanding that DNA determines the phenotype of the organism. Humans can use biotechnology to help improve the phenotype of organisms, from agriculture, to disease treatment.

Essential Questions
What essential question(s) does this lesson address?

How does your DNA determine your if you are healthy or not?

Students will understand that…
What should the students understand by the end of today's lesson?

This lesson covers multiple days, in the end they should be able to:

- Describe the structure of DNA
- Describe DNA Replication
- Describe Central Dogma
- Explain the importance of DNA
- Describe they types of Mutations and their effect on offspring or individuals
- Discuss the importance of the biotechnologies used (assays, RFLP, Gel Electrophoresis)

Connecting Concepts
How will you review yesterday's content and connect today's lesson to it?

Between each lesson there will be a short review with guided questions (done as do now), if there is no TBL. Which will link 's information or manipulative to the next day's lesson.

Standard(s)/Benchmark(s)
What standard(s)/benchmark(s) does this daily lesson address?

SC.912.L.16.3: Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information

SC.912.L.16.4: Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring.

SC.912.L.16.5: Explain the basic processes of transcription and translation, and how they result in the expression of genes.

SC.912.L.16.9: Explain how and why the genetic code is universal and is common to almost all organisms.

SC.912.L.16.10: Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.11: Discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis.

Organizing Students for Learning
How will students be organized today for the lessons activities?

For each part of the lesson students will be organized in pairs, or in their groups of 4-5 students. Their lab groups will be the same as their TBL groups.

DNA- TBL
Central Dogma- TBL/Lab groups
Mutations- individual lecture/Lab Groups for manipulative
Pompe- Jigsaw then lab groups
Blast- partners
Biotechnology – lab groups

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES
What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Students will complete an anticipations guide their pre-tests, and self-reporting surveys. Short discussion, "What do you know about DNA and its current uses?"	☐ ABC Brainstorming ☐ KWL ☒ Anticipation Guide ☐ Card Sort ☐ Think-Pair-Share
Explicit Instruction	Students will be instructed via a Flipped Classroom on topics of DNA replication/structure DAY 1 , as well as Central Dogma DAY 2 , and mutations DAY 3.	☐ Motivational Hook ☐ Lecture ☐ Demonstration ☒ Note-taking Guide

<table>
<tr><th colspan="3">Lesson Sequence</th><th>Resources and Materials</th></tr>
<tr><td>Group Processing of New Information</td><td>Group work:
• TBL review/lesson on DNA Structure/Replication
• Sciene take-out on DNA to Protein
• Jigsaw Pompe activity to confirm protein abnormalities effect in humans.
• Timiline activity on clinical trials, Pompe history</td><td>☒ Jigsaw
☐ Reciprocal Teaching
☐ Concept Attainment
☐ Think-Pair-Share</td><td rowspan="6">☐ Lab / Inquiry Activity</td></tr>
<tr><td>Elaborative Questioning</td><td>Each assignment will have questioning at the end, as well as open discussions with the class.</td><td>☐ Inferential Questions
☒ Analytic Questions
☐ Philosophical Chairs</td></tr>
<tr><td>Demonstrating Understanding</td><td>Students will work with a partner to do the BLAST activity, which they will BLAST a given gene sequence, identify the mutation, explain the mutation and the resulting heritable disease. Class discussion, and accuracy of poster will demonstrate understanding of mutations.
Also, “Putting it all together” Lab from Pompe, student will demonstrate understanding of the central dogma, and mutations effects on Proteins.</td><td>☐ Graphic Organizers
☐ Picture Notes
☐ Flow Charts
☐ Concept Maps
☐ Mnemonics
☐ Graffiti</td></tr>
<tr><td>Reflection</td><td>Daily students will answer a reflective journal prompt, on what they have learned each day.</td><td>☐ Reflective Journals
☐ Think Logs
☐ Exit Ticket (Student Learning)</td></tr>
<tr><td>Daily Progress Monitoring Assessment</td><td>TBL- has embedded quiz
Quiz On day Day 3 and 4
Post tests- Post Self-reporting surveys.
Labs Reports will confirm their understanding of each concepts: Central Dogma, and Heredity.</td><td>☒ Quiz
☐ Journal
☐ Exit Ticket (for Content)
☐ Response Cards</td></tr>
<tr><td colspan="3">Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?
I may review Central Dogma if needed.</td><td>Homework
Day 1 Assign DNA replication/structure guided notes, DAY 2 Assign Central Dogma guided notes, Day 3 Mutations home notes.</td></tr>
</table>

☒ Computer
☒ LCD Projector
☒ Paper
☒ Pencils
☒ Whiteboards
☒ Markers
☒ Butcher Paper
☒ Response Cards
☐ Post-it Notes
☒ Video Clip(s):

☐ Website(s):

☒ Lab Materials:

Chapter 13 Meiosis and Sexual Life Cycles	Teach prior to action proposal, short lecture, comparison/contrast with mitosis
Chapter 14 Mendel and the Gene Idea	Teach Mendellian genetics/recombinant frequency/chi-square/non mendellian genetics/
Action Proposal: Pre-test 30 MC Questions and Pre-Survey DAY 1	
Chapter 15/16 DAY 2	History Disovery of DNA Video from HHMI-guided notes/timeline/guided textbook notes(structure/replication). TBL on DNA structure/history. **Manipulative:** Model of Origin of replication large- different proteins place where they go, put steps in order.
Chapter 17 Protein Synthesis DAY 3	Central Dogma-Hwk Bozeman Videos, with guided Notes Short Lecture on steps. Initiation/elongation/termination **Manipulative:** Science Take Out DNA to Protein Parts A/B
Gene Mutations DAY 4	Mutations, types, **Manipulative** Science Take out DNA to Protein Part C
Hereditary Diseases DAY 5	Gene is DNA sequence/Mutations/Enzymes **Manipulative:** BLAST activity, given DNA sequence, find type of mutation, genetic disease and information about the disease.
POMPE Discussion DAY 6	Gene Mutation Looking through a Father's Eyes
POMPE Road to Treatment DAY 7	Biotech ERT **Manipulative:** Timeline activity- understand clinical trials, ERT/enzyme replacement therapy
POMPE Putting it all Together "Clinical Laboratory Protocal" DAY 8	Central Dogma/ Bio Tech Assay **Wet Lab /Manipulative /Biotech Acid Alpha-Glucosidase Activity Assay**
Prep for Nature's Dice DAY 9	Gel Electrophoresis/DNA fingerprinting via paper RFLPs activity
Modes of Inheritance DAY 10	Genetic Screening, Gel Electrophoresis, Pedigree, Genes, Inheritance Mendellian genetics **Wet Lab/Manipulative/ Biotech:** Nature's Dice Genetic Screening/Gel Electrophoresis
DAY 11 Day to Review, finish Labs , discussion	
Post Test/ Post Surveys Day 12	
Control of Gene Expression	Guided Notes- POGIL (Process Oriented Guided Inquiry Learning) Control of Gene Expression
Transformation	Tentative C. elegans Lab or Bacterial Transformation

Blue=Concepts I expect to be mastered **Orange= Equipment Locker Needed**

UNIT PLAN

Unit Title: Genetics	**Content Area/Grade: AP Biology / 9-12**
Teacher: Ms. Shavon Brookman	**Implementation Time Frame: 4 weeks**

STAGE 1: THE DESIRED RESULTS

What are my learning goals?

Unit Goal

Students will understand that…

Genetics, is understanding that sequences of DNA organized into genes determines the phenotype of an organism. These genes are inheritable. Humans can use biotechnology to help improve the phenotype of organisms, from agriculture, to disease treatment.

Related Misconceptions

What misconceptions are predictable?

-All genes are single gene (dominant/recessive/follow mendel)
-all mutations are harmful
-if the trait is dominant, it is most common
-mutations can easily be fixed

Essential Questions

What questions will foster inquiry, understanding and transfer of learning?

How does you inherited DNA determine your traits?

Students will know…

Vocabulary, terminology, definitions

Mendellian Genetics, Nonmendellian genetics, recombinant DNA, law of segregation, law of independent assortment, chi square, pedigree, genome, chromosome, histone, acetylation, methylation, centromere, dominant, recessive, phenotype, genotype, dna replication, transcription, translation, mrna, mrna processing, mutations, nonsense, frameshift, substitution, deletion, insertion operator, transcription factor, splicesome, operator, promoter, gel electrophoresis, RFLPs

Standard(s)/Benchmark(s)

What standard(s)/benchmark(s) does this daily lesson address?

SC.912.L.16.3
Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information

SC.912.L.16.4
Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring.

SC.912.L.16.5
Explain the basic processes of transcription and translation, and how they result in the expression of genes.

SC.912.L.16.6
Discuss the mechanisms for regulation of gene expression in prokaryotes and eukaryotes at transcription and translation level.

SC.912.L.16.9
Explain how and why the genetic code is universal and is common to almost all organisms.

SC.912.L.16.10
Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.11
Discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis.

SC.912.L.16.12
Describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning)

Students will know…

key facts, formulas, critical details, important events, important people, timelines

Other Essential Knowledge : Timeline discovery of DNA, Chargaff, Watson and Crick, Rosalind Franklin, Avery, McCleod etc. Formulas Chi Square, and recombinant frequency,

Students will be able to…

This lesson covers multiple days, in the end they should be able to:

- Perform prediction of gene inheritance using punnett squares
- Calculate recombinant frequency
- Calculate chi square
- Describe the structure of DNA
- Describe DNA Replication
- Describe Central Dogma
- Explain the importance of DNA
- Describe they types of Mutations and their effect on offspring or individuals
- Discuss the importance of the biotechnologies used (assays, RFLP, Gel Electrophoresis)
- Explain gene regulation in bacteria and humans

STAGE 2: ASSESSMENT EVIDENCE

What evidence will show that my students have achieved the learning goals?

Performance tasks:

Through what specific "real-world" performance task(s) will students demonstrate their understanding of the learning goals?

Through the Pompe Activity, real world situation in which in the end students will demonstrate understanding of the central dogma, as well as enzyme assay.

Through the real world Nature's Dice activity, students will perform a genetic screening which will confirm their understanding of inheritance, creating a pedigree, interpreting a pedigree, and biotechnological skill of working with gel electrophoresis.

Rubric

By what criteria will "performance of understanding" be judged?

Graded Quizzes, Tests, and Lab reports

Other Evidence: What other evidence needs to be collected in order to monitor student progress on these concepts and skills along the way?	**Self-Assessment/Reflection** How will students reflect and self-assess their learning?
Pre/Post Tests, Pre/Post Surveys Daily quizzes or reflective writings	Via surveys, and reflective writing at the end of each class period.

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES
What activities will help my students achieve the learning goals?

What **H**ere	**What** is expected? How will you ensure that students are aware of the learning goals? **Where** are your students? How will you establish your students' prior knowledge?
Hook **H**old	How will you **hook** students at the beginning of the unit? How will you **hold** their attention throughout the units?
Experience **E**xplore **E**quip	What critical input **experience** will help students **explore** the key ideas and essential questions? How will you **equip** your students with needed skills and knowledge?
Reflect **R**ethink **R**ehearsing **R**evising **R**efining	How will you encourage students to **reflect** and **rethink**? How will you guide students in the process of **rehearsing**, **revising**, and **refining** their work?
Exhibit **E**valuate	How will you help students to **exhibit** and **self-evaluate** their developing skills, knowledge and understanding throughout the unit?
Tailor	How will you **tailor** your instruction to meet the different needs, interests and abilities of all learners in your classroom?
Organize	How will you **organize** and sequence the learning activities to maximize the engagement and achievement of all students?

Big Idea:		Standard(s)/Benchmark(s):
Unit:		Sample Activities
Grade:		
Score 4.0	**In addition to Score 3.0, in-depth inferences and applications that go beyond what was taught.**	
Score 3.0	**The student:** **The student exhibits no major errors or omissions**	
Score 2.0	**There are no major errors or omissions regarding the simpler details and processes as the student:** • Recognizes or recalls specific terminology • Performs basic processes, such as: **However, the student exhibits major errors or omissions regarding the more complex ideas and processes**	
Score 1.0	**With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes.**	
Score 0.0	**Even with help, no understanding or skills demonstrated.**	