Syllabus
Course Revision: Define and identify the ‘5 postulates’ of science (tentativeness, multi-modal, social, non-objective, human endeavor) on the first day. Use the rest of the course to emphasize and illustrate the postulates. Every assignment, discussion, reading, anecdote can be used as evidence.

Science for Secondary Science Teachers
Mondays and Thursdays 4:00-7:00*
AND 3 web-based sessions
Dugan 207
Total contact hours 30 (in-class) + 7.5(online)
Instructor: David Lustick
Office: O’Leary 530
978 934 4644
Summer Office Hours:
Thursday 2:30-3:30 (Dugan 207)

Webcourse: https://learning.umassonline.net/webct/urw/lc26262.tp0/cobaltMainFrame.dowebct

Instructor’s Website
http://gse.uml.edu/gse/about/faculty/lustick.htm

Email
David_Lustick@uml.edu

* Add/ drop date without penalty is June 6th *

Education for Transformation

A theme entitled “Education for Transformation” provides a conceptual framework that unifies programs at the Graduate School of Education. The mission of the University of Massachusetts Lowell is to meet the needs of the Commonwealth today and into the future by supporting the development of sustainable technologies and communities through its teaching, research, scholarship and engagement. The Graduate School of Education (GSE) contributes to this mission by educating new teachers and enhancing the
professional development of those already in the field so that they may assume leadership roles focused on transforming the lives of children and the vitality of the region.

The GSE’s commitment to "Education for Transformation" produces graduates who:

- demonstrate excellent knowledge, judgment and skills in their professional fields;
- promote equity of educational opportunity for all learners;
- collaborate with other educators, parents and community representatives to support educational excellence;
- use inquiry and research to address educational challenges.

The fundamental tenets of the school are excellence, equity, collaboration and inquiry.

To this end, the course “Science for Secondary Science Teachers” helps you to develop your knowledge of science, use the findings of research and apply your learning to the evaluation and development of appropriate curricula. This course thus requires that you demonstrate your knowledge, judgment and skills - necessary components of an educator committed to transformation of school science.

* Except Monday May 30th, Memorial Day Holiday

Science for Secondary Science Teachers is ONE of the FOUR core science education courses in the M.Ed. Initial Licensure Program. The other three courses are:

- Curriculum and Teaching Science
- Interactions in the Science Classroom
- Assessment in Science

*If you already hold Initial Licensure in the Commonwealth of Massachusetts, and are seeking Professional Licensure, you should NOT ENROLL in any of these core science courses.*

All of the courses in the Initial Licensure Program for the sciences are aligned with the National Science Teachers Association Standards for Science Teaching. The three areas of those standards pertaining to this course are: 

*Conceptual Content of the Natural Sciences.*
Understanding of the structure of science, demonstrated by being able to:

- articulate and interpret the important UNIFYING concepts, ideas, and relationships in physics, chemistry, biology and/or earth science;

**History, Nature, and Philosophy of Science.**

Understanding of the history, philosophy, and practice of science, demonstrated by being able to:

- distinguish science from non-science,
- depicting the evolution and practice of science as a human endeavor,
- critically analyzing claims made in the name of science.

### Readings for the Course

**INTERNET SOURCES**

**National and State Standards for Science Teaching**
Published by the National Research Council, at:
http://www.nap.edu/readingroom/books/nses/html/

**Massachusetts Frameworks for Science and Technology**

http://www.doe.mass.edu/omste/
Then click on CURRICULUM AND ASSESSMENT

Massachusetts adopted the standards in 1996 and through a SYSTEMIC INITIATIVE called PALMS - Partnerships Advancing Learning in Mathematics and Science - the State is moving toward higher levels of scientific literacy.

**Project 2061**

An additional resource should be Project 2061 - Benchmarks for Science published by the American Association for the Advancement of Science:

http://www.project2061.org/default_flash.htm

**LINKING TO**

http://www.project2061.org/tools/benchol/bolintro.htm
Required Text


Course Overview - Graphic
Example A
As Understanding By Design is to be utilized during this course, it is developed using these principles.

Teaching science is not just about covering content. An education in science should also help students to understand the Nature of Science (often through history); how science is done; and how science impacts society—and society impacts science.
UNITS WITHIN THIS COURSE

History of Science
What use is the history of science if we have left all those ideas behind?

History helps us to understand the many ways in which scientific discovery comes about and how scientific knowledge becomes accepted.

Science Today
What does science today tell us about the nature of science?

Scientific discourse around unresolved issues illustrate the nature of science and provide a treasure trove of opportunities for teachers.

Science Education
How can the nature and history of science be used to bring forth learning?

History and Nature of science provides valuable context for scientific content knowledge that teachers can use to motivate, inspire, and support student learning of difficult concepts.

Course Overview – Units

Unit 1: History of Science: What use is the history of science if we have left all those ideas behind?

<table>
<thead>
<tr>
<th>Unit Enduring Understanding</th>
<th>Essential Questions</th>
<th>NSTA Standards (MA Standards)</th>
</tr>
</thead>
</table>
| History helps us to understand the many ways in which scientific discovery comes about and how scientific knowledge becomes accepted. | (i) Is there ‘a’ scientific method?  
(ii) How does scientific knowledge develop?  
(iii) To what extent can we rely on scientific knowledge?  
(iv) Does an historical perspective help students to learn science concepts? | ➢ distinguish science from non-science,  
➢ depict the evolution and practice of science as a human endeavor,  
➢ critically analyze claims made in the name of science.  
➢ Understand the philosophical tenets assumptions, goals and values that distinguish science from technology and from other ways of knowing the world |
### Unit 2: Science Today: What does the science happening today reveal about the nature of science?

<table>
<thead>
<tr>
<th>Unit Enduring Understanding</th>
<th>Essential Questions</th>
<th>NSTA Standards (MA Standards)</th>
</tr>
</thead>
</table>
| Today’s scientific controversy is tomorrow’s history. Scientific knowledge is generated and disseminated through social, political, and research communities. | (i) What can research on climate change tell us about the nature of science?  
(ii) How does the social and political context of research influence science? | ➢ Understand research and can successfully design, conduct, report and evaluate investigations in science.  
➢ Successfully use technological tools, including but not limited to computer technology, to access resources, collect and process data and facilitate the learning of science. |

### Unit 3: Science Education: How can the history and nature of science be used to improve teaching and learning?

<table>
<thead>
<tr>
<th>Unit Enduring Understanding</th>
<th>Essential Questions</th>
<th>NSTA Standards (MA Standards)</th>
</tr>
</thead>
</table>
| Historical and contemporary examples of research provide valuable context for students to succeed in science. | (i) What types of questions might be accessible to students, of interest to them, and result in discoveries for them?  
(ii) What do we expect students to learn from conducting authentic scientific investigations? | ➢ Engage students successfully in studies of the nature of science including, when possible, the critical analysis of false or doubtful assertions made in the name of science  
➢ Understand the curricular recommendations of the NSES and can identify, access, and/or create resources and activities for science education that are consistent with the standards |
<table>
<thead>
<tr>
<th>Session</th>
<th>Objectives</th>
<th>Work for next class</th>
</tr>
</thead>
</table>
| 1 Unit 1 May 23 | What is this thing called “Science”?
Who are scientists?
How does one tell a good story in science? | Feynman (1974) Cargo Cult Science
Sagan, 1989 and 1996
Choose a Scientist
Story 1 |
| 2 Unit 1 May 26 | What is the difference between the following statements:
  a) Science says human activity is the cause of global warming.
  b) Scientific research indicates that human activity is the likely cause of global warming. | Read Derry Prologue, Chpts. 1- 6
Continue your biography reading.
Story 2 |
| Online Discussion 1 May 29– June 4 Unit 1 | What is the scope of school science?
Has it always been this way?
What influences what is included in school science?
Refer to Project 2061 for specific Standards. |
| 3 Unit 1 June 2 | How can the quest for limitless energy inform us about the nature of science? | As Falsification by Karl Popper (1963), “Is the Theory of Evolution non-falsifiable?” by David Hone (2009) |
| 4 Unit 1 June 6 | What do the people who make their life in science tell us about science?
Biography presentations | Kuhn (1962) Historical Structure of Scientific Discovery
Read the Galileo Papers
Story 3 |
| 5 Unit 2 June 9 | What does Thomas Kuhn’s ideas about scientific discovery improve our understanding of the nature of science?
What can Galileo’s struggles with the Church tell us about science today? | Read the Dolphin Papers
Derry Chapters 7-13. |
| Online Discussion 2 June 12–18 | What does current research reveal about the nature of science and scientific knowledge?
How does the media inform our understanding? | Assignment 1 Due June 20 |
NBPTS (2004) Big Ideas in Science
Story 4 |
| 7 Unit 2 June 16 | How do we teach (or not teach) with the History of Science? Where does science begin? | Allchin (2000), Wasserman (1992)
Walker (2002) Science Education is no Guarantee of Skepticism Lustick 2010 |
| Online Discussion 3 June 26–July 2 | Current Science Issues: What are the science stories that are most important to your discipline? Why? |  |
| 8 Unit 3 June 20 | What makes a good question? What is the Big Idea in science? How do we use good questions in class? | Matthew’s Editorial Study Group
Read the Mindwork materials
Story 5 |
| 9 Unit 3 June 23 | How does available curriculum address HOS/NOS? How do quality focus questions help us develop productive teaching and learning experiences? | TBA |
| 10 Unit 3 June 27 | The Myth of Method: Is There A Scientific Method?
What do students understand about the nature of science? Facts, Laws, Models, Theories – what are they? | Finish Assignment 3
TBA |
| 11 Unit 3 June 30 | Final Question Projects: What did you discover?
Teaching with controversy | You are done (almost)!
Assignment 3 is due July 5th |
TOPIC – ATTENDANCE AND LATE POLICY

- You are expected to attend ALL sessions for the specified time. In the event that you must miss a class, the instructor must be informed in advance and make-up work must be completed.
- If you miss more than 2 classes you must withdraw from the course.
- You must contribute to all three online sessions – late policy applies to these too.
- Continual lateness (more than twice) to class, may result in 2 point reduction/event.
- Late assignments (without permission) will result in a 2 point reduction/day late. Once an assignment is more than 7 days late it will not be graded, but it must be submitted in order for the student to receive a grade in the course.
- If you miss a class, you are still responsible for getting the assignment in on time.
- If the instructor knows that she can extend an assignment due date, she will ensure that all students are told, otherwise the dates on this syllabus stand.
Overall Grading Criteria

**COURSE GRADING STRUCTURE**

<table>
<thead>
<tr>
<th>Grade</th>
<th>GPA</th>
<th>Point structure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>4.0</td>
<td>99-100</td>
<td>Work of the highest professional standard demonstrating independent and exemplary performance</td>
</tr>
<tr>
<td>A</td>
<td>4.0</td>
<td>96-98</td>
<td>Excellent work demonstrating independent and high quality performance.</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
<td>91-95</td>
<td>Very good work, carefully executed, but requiring some areas of improvement.</td>
</tr>
<tr>
<td>B+</td>
<td>3.3</td>
<td>86-90</td>
<td>Good work, indicating careful thought and attention to the task, yet requiring several areas of improvement.</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
<td>80-85</td>
<td>Work of graduate standard, but omissions exist or careful analysis is not in evidence.</td>
</tr>
<tr>
<td>Below Graduate Standard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-</td>
<td>2.7</td>
<td>76-79</td>
<td>Effort is evident, but work indicates lack of understanding of the demands of the task</td>
</tr>
<tr>
<td>C+</td>
<td>2.3</td>
<td>70-75</td>
<td>Poor quality work with little attention to detail and the demands of the task.</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
<td>65-69</td>
<td>Work of very poor quality, indicating no understanding of the depth of analysis required.</td>
</tr>
<tr>
<td>F</td>
<td>0.0</td>
<td>Below 65</td>
<td>Serious neglect or evidence of cheating.</td>
</tr>
</tbody>
</table>

**COURSE POLICIES**

**ALL ASSIGNMENTS MUST BE SUBMITTED TO PASS THE COURSE.**

**Late Assignments**
For every day that an assignment is submitted late, you lose a point.
Once an assignment is 7 days late it will NOT be graded, but IT MUST be submitted.
Withdrawal from Course and Incomplete Policy
If you are behind in your course work or you have not participated regularly in the required on-line discussion board or you have missed several classes, then you may be advised to WITHDRAW from the course. You will lose the money you paid for the course, but a W rather than an F will be recorded on your transcript. PLEASE do not ask for an incomplete grade unless you or a close family member has suffered a severe illness or other emergency situation.

I RESERVE THE RIGHT TO SUBTRACT UP TO FIVE POINTS FROM YOUR TOTAL IF LATENESS TO CLASS OR UNPREPAREDNESS INCONVENIENCES ME OR PLACES UNDUE PRESSURE ON PEERS.

Assignments – DUE DATES AND POINTS

There are 4 graded assignments for this course. All four assignments must be submitted if the student is to pass the course. No incomplete grades will be allowed except for medical reasons with a doctor’s note.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Due Date</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Work of a scientist</td>
<td>June 20th</td>
<td>25</td>
</tr>
<tr>
<td>2 Stories of Discovery</td>
<td>May 26, June 2, June 9, June 16, and June 23</td>
<td>25</td>
</tr>
<tr>
<td>3 Nature/History of Science Project</td>
<td>July 5th</td>
<td>25</td>
</tr>
<tr>
<td>4 Web-Board Contributions</td>
<td>» #1 by June 4</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>» #2 by June 18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» #3 by July 2</td>
<td></td>
</tr>
<tr>
<td>5 Class Participation</td>
<td>Throughout</td>
<td>10</td>
</tr>
<tr>
<td><strong>MAXIMUM POSSIBLE COURSE TOTAL</strong></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
ASSIGNMENT 1 – WORK OF A SCIENTIST – JUNE 20th

In order to demonstrate your knowledge of the practice of science as a human endeavor and to illustrate how aspects of the nature of science are illustrated, you will:

Read a biography (or autobiography) of a scientist
Some suggestions are listed below, but you are not restricted to these. Each member of the class must choose a different person. Please check with me. Barbara McClintock, Rosalind Franklin, Lise Meitner, Jane Goodall, Nikola Tesla, Richard Feynman, E.O. Wilson, Stephen Jay Gould, Charles Darwin, Niels Bohr, Edwin Hubble, Alfred Wegener, Luis Aggasiz, Linus Pauling

Assignment requirements
PRESENTATION – 15 POINTS
A video, narrated powerpoint production, or animated presentation suitable for posting on Youtube. The multi-media presentation should use the biography as a base to address the requirements of the assignment. Additional resources are allowable and encouraged. Your primary audience for your video file should be secondary science teachers, however it should also be meaningful to secondary science students.

Not necessarily in this order, you will describe your scientist’s
- Contribution to science
- Brief Background Profile (birth, where they studied, where they lived and worked, etc.)
- How s/he conducted his/her work
- Issues they encountered in doing their work
Impediments to the acceptance of his/her ideas
Connections to possible topics/units/lesson in science class (i.e. why is this person important to your field?)

The Video must be:
2-5 minutes in length
Include titles (beginning) and credits (end)
Site all sources at the end of the production
BE POSTED TO TEACHERTUBE (http://www.teachertube.com) or YOUTUBE (http://www.youtube.com) BY THE DUE DATE.
Once posted, please send me the URL of the video.
Here are some examples:
http://www.youtube.com/watch?v=8it6F8JhJT s
http://www.youtube.com/watch?v=QCGr r89AZm4

Assessment criteria for presentation will be based on:
Accuracy of information shared: Is everything presented factually accurate according to the best information available?
Accessibility of information: Is the information presented in such a manner as to be easily understood upon viewing by intended audience?
Accountability of information: Is the information precisely supported by reputable sources and the biography?
Engagement: Do you develop a presentation that is engaging to the viewer?
Completeness and Timeliness of Project: Did you do everything you were supposed to and posted it to Youtube on time?
ASSIGNMENT 2 – Stories of Scientific Discoveries – May 26, June 2, June 9, June 16, and June 23

Assignment 2: Stories of Scientific Discoveries (5 stories)
The purpose of Assignment 2 is for you to connect the stories of discovery to classroom teaching. You will create four stories of discovery:

1) Something Old from your Content Area (May 26)
2) Something New from your content area (June 2)
3) Something Old from a different content area (June 9)
4) Something New from a different content area (June 16)
5) Your Choice (June 23)

For each discovery, you will:

a) Complete a Discovery Summary
b) Tell your story of scientific discovery to class (2-5 minute presentation).

Each presentation should be on a different discovery, topic, and NOS focus.

Discovery Summary

1. Provide an Interesting Title
2. Tell the story of discovery in 500 words or less. In your story, make sure you include the following points:
   A. Who? (Actual scientist(s), laboratory, funders)
   B. What? (The focus of the story)
   C. When? (actual discovery, publication date)
   D. Where? (nationality of scientists, location of research)
   E. Significance? (why should anyone care about this discovery)?
3. Identify the MA Science Frameworks Standards which are supported by this discovery.
4. What units/topics might you use this story in your teaching?
5. How might this discovery impact students’ understanding of the nature of science?
6. References
ASSIGNMENT REQUIREMENTS

<table>
<thead>
<tr>
<th>Complete Discovery Summary</th>
<th>Completeness</th>
<th>Accuracy of Content</th>
<th>Quality of Ideas</th>
<th>Connection to topics (science and other disciplines)</th>
<th>Communication (grammar, spelling, structure)</th>
</tr>
</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>Telling the Story</th>
<th>Time/word limit</th>
<th>Engaging (eye contact, clarity of speech, gestures, word choices)</th>
<th>Science Content (accuracy, relevancy, technical kept to a minimum)</th>
<th>Relevance to Topic</th>
</tr>
</thead>
<tbody>
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</table>

Story Teller Feedback Rubric

<table>
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<tr>
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<th>3</th>
<th>2</th>
<th>1</th>
<th>Comment</th>
</tr>
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<tr>
<td>Written Discovery Summary</td>
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</tr>
<tr>
<td>Title</td>
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<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Who?</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
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<td>What?</td>
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<td>3</td>
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<td>1</td>
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<tr>
<td>When?</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Where?</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>Significance</td>
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<td>3</td>
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<tr>
<td>References</td>
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<td>Word Limit</td>
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<tr>
<td>Telling the Story</td>
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<tr>
<td>Hook</td>
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<td>Eye Contact</td>
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<td>3</td>
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<td>1</td>
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<tr>
<td>Voice</td>
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<tr>
<td>Body Language</td>
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<tr>
<td>Pace</td>
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<tr>
<td>Language</td>
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<td>Engagement</td>
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<tr>
<td>Relevance</td>
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<td>Scientific Accuracy</td>
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<td>Time</td>
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<td>OVERALL</td>
<td>4</td>
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</tbody>
</table>
## ASSIGNMENT 3 – Nature/History of Science Learning Project – July 5th

The purpose of Assignment 3 is for you to take the ideas, concepts, and theories associated with the nature and history of science and apply them to classroom teaching within the framework of the Massachusetts Curriculum Standards. There are several options for this project:

1) Design and Construct a WebQuest that addresses the history & nature of science within a **specific concept related to your content area** of expertise. Post your webquest online. Write a 4 page narrative that describes how each part of the webquest achieves its intended learning goals. Use class readings to support your choices.

2) Identify a series of activities students can do in class that address a **specific concept related to your content area** of expertise and write a 4 page critique of the selected activities. The critique should identify strengths and weakness regarding NOS and HOS and changes that would improve student learning of each of these areas. Use class readings to support your analysis.

3) Write a 10 page research paper on the history & nature of science that addresses a **specific concept related to your content area of expertise**. In particular, you want to investigate a phenomenon with an eye for how it could be used to engage learners in specific standard based learning objectives. Use class readings to support your research.

Regardless of which option you choose, you will have to:

1) Start your project with a good focus question that will engage learners/readers and be addressed by the project.
2) Identify the unit(s) and relevant standards within the MA Frameworks for which the project applies.
3) Complete list of references used in APA format.
4) Informally Present your work to class

*If you are a middle school teacher, you may choose from the following list of UNITS:*
- Chemical building blocks
- Cells and Heredity
- Forces and Motion
- Weather and Climate
- Earth’s Changing Surface
Websites to help you
http://www.phschool.com/atschool/science_explorer/
http://www.riverdeep.net/science/ms_gateways_teachersupport.jhtml

If you are a biology teacher you must use either:
Evolution
DNA and Heredity
Classification
Deep Time
http://www.riverdeep.net/science/hs_gateways_teachersupport.jhtml

If you are a chemistry teacher you must use either:
Stoichiometry
Acid and Base Chemistry
Periodic Table
Atomic Theory
http://www.chemistrycoach.com/home.htm

If you are a physics teacher you must use either:
Energy and Motion
Electromagnetism
Newton’s Laws of Motion
Special Relativity
http://www.riverdeep.net/science/ms_gateways_teachersupport.jhtml

If you are an earth science teacher you must use either:
Global Climate
Earth’s changing surface
Deep Time
Fossils
http://www.riverdeep.net/earthscience/data/earthscience/earthscience_jump.jhtml
*If you would like to do a unit not listed here, please talk it over with me for final approval.
## Assignment 3: N/HOS Project Grading Sheet

Your Name: ________________________________

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Points Available</th>
<th>Your Points</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical</strong> aspects of writing (spelling, grammar, punctuation, title page, font, spacing)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Explanation</strong> of Solution</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality of Activities/Sites/Research</strong></td>
<td>5</td>
<td></td>
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<tr>
<td><strong>Units</strong> where question could be used.</td>
<td>2</td>
<td></td>
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<tr>
<td><strong>MA Standards</strong> supported and brief explanations for each.</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>References</strong></td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td><strong>YOUR TOTAL OUT OF</strong></td>
<td>20</td>
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</tbody>
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ASSIGNMENT 4 – WEBBOARD - BY June 4/June 18/July 2

THE TASK
1. You will be required to log on to the web-board at:

http://lowell.umassonline.net/index.cfm

On the web-board a question will be posed by the instructor. You must make TWO responses to the question that indicate that you have given your opinion and also responded to your peers’ comments.

Grading criteria for Assignment 4

<table>
<thead>
<tr>
<th>CRITERION</th>
<th>TOTAL 10 POINTS</th>
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<tbody>
<tr>
<td>You have made 2 reasoned responses for each web posting</td>
<td>1 points</td>
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<tr>
<td>Your responses were made on time.</td>
<td>1 points</td>
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<tr>
<td>Your responses were either first or built upon something you read in the</td>
<td>8-7 points</td>
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<td>responses of your peers. Responses were succinct, well reasoned and</td>
<td>6-4 points</td>
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<td>indicated that you had drawn upon relevant readings, some life experiences,</td>
<td>3-0 points</td>
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<tr>
<td>class and web-board discussion</td>
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