Syllabus

Science for Secondary Science Teachers
Mondays and Thursdays 4:00-7:00*
AND 3 web-based sessions
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

Webcourse:
http://vappsrv-prd.umassonline.net/webct/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 9th*

Education for Transformation

The central tenets of our conceptual framework are Excellence, Equity, Inquiry and Collaboration. The GSoE strives through its programs to assist its students to excel in content and pedagogical knowledge, equipping them to play a leadership role in the region. Our graduates are expected to demonstrate commitment to 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 26th, 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 Texts (2)

Course Overview - Graphic

Example A

As Understanding By Design is to be utilized during this course, it is developed using these principles.

Worthwhile being familiar with as a result of taking 04.525

Important to know and do as a result of taking 04.525

Enduring Understanding from 04.525

➢ Historical information that helps to elucidate the nature of science.
➢ Issues involved in investigating scientifically

➢ Standards and unifying concepts of science.
➢ How to sequence a curriculum to encompass all aspects of science and engage student interest.

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.

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 | ➢ 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>
<tbody>
<tr>
<td>Historical and contemporary examples of research provide valuable context for students to succeed in science.</td>
<td>(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?</td>
<td>➢ 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.</td>
</tr>
</tbody>
</table>
## COURSE SEQUENCE (SUBJECT TO CHANGE)

<table>
<thead>
<tr>
<th>Session</th>
<th>Objectives</th>
<th>Work for next class</th>
</tr>
</thead>
</table>
| 1 Unit 1 May 29 | **What is this thing called “Science”?**  
Who are scientists?  
What is the difference between nature of science and history of science? | 1) Read Derry Prologue, Chpt. 1-3, Chpt 6 pages 69-81  
2) Choose a Scientist |
| 2 Unit 1 June 2 | **To What Extent Can We Rely On Scientific Knowledge?**  
How do we distinguish science from non-science?  
What makes knowledge ‘scientific’? | Read Derry Chapters 9 through 13  
Start Reading Koestler  
Continue your biography reading. |
| Online Discussion 1  
*June 2 – June 8* | **What is the scope of school science?**  
Has it always been this way?  
What influences what is included in school science?  
To what extent are we expected to address the nature of science? | Read Yager (2000) The History of Science Education Reform.  
Refer to Project 2061 for specific Standards. |
| 3 Unit 1 June 5 | **What does the Case of the Midwife Toad tell us about science?** | Continue biography reading.  
Biography Presentation due next class |
| 4 Unit 1 June 9 | **What do the people who make their life in science tell us about science?**  
**Biography presentations** | Read the Galileo Papers  
Read Cooney p1-64  
**Assignment 1 due**  
**Oral Presentation of Scientist** |
| 5 Unit 2 June 12 | **What can Galileo’s struggles with the Church tell us about science today?** | Read the Dolphin Papers  
Read Cooney p65-101 |
| 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? | Wasserman (1992) |
| 6 Unit 2 June 16 | **How does social/political/economic interests influence science?** | Read Allchin (2000) |
| 7 Unit 2 June 19 | **What makes a good question?**  
**How do we use good questions in class?** | |
| Online Discussion 3  
*June 23 – 29* | **Current Science Issues: What are the science stories that are most important to your discipline? Why?** | |
| 8 Unit 3 June 23 | **How do we teach (or not teach) with the History of Science?**  
**Assignment 2 is Due** | Read the Mindwork materials  
**Assignment 2 Due** |
| 9 Unit 3 June 26 | **How does Mindworks serve the goals of science education?** | Read Derry Chpt 4 & 5 |
| 10 Unit 3 June 30 | **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:  
**Oral Presentations Due** |
| 11 Unit 3 July 3 | **Final Question Projects: What did you discover?** | You are done!  
**Assignment 3 is due!** |
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>
</tbody>
</table>

Below Graduate Standard

<table>
<thead>
<tr>
<th>Grade</th>
<th>GPA</th>
<th>Point structure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<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 5th</td>
<td>25</td>
</tr>
<tr>
<td>2 Scientific Discourse</td>
<td>June 23th</td>
<td>25</td>
</tr>
<tr>
<td>3 Nature/History of Science Project</td>
<td>July 3rd</td>
<td>25</td>
</tr>
<tr>
<td>4 Web-Board Contributions</td>
<td>» #1 by June 8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>» #2 by June 18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>» #3 by June 29</td>
<td></td>
</tr>
<tr>
<td>5 Class Participation</td>
<td>Throughout</td>
<td>10</td>
</tr>
<tr>
<td>MAXIMUM POSSIBLE COURSE TOTAL</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>
ASSIGNMENT 1 – WORK OF A SCIENTIST – JUNE 9th

In order to demonstrate you 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 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
ORAL PRESENTATION – 15 POINTS
You will write and deliver a power-point presentation of your scientist

- Contribution to science
- 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

Your presentation must be timed at no more than 10 minutes
Your presentation must include a TITLE slide with photograph of the scientist
You may have no more than 7 powerpoint slides in total.
Your oral skills will be assessed.

Assessment criteria for presentation will be based on:
Timing and slide criteria met
Fluency of your presentation (you have obviously practiced)
Ability to engage audience (eye contact and Voice Dynamics important)
Accuracy of the information
All aspects of the assignment (listed above) are included
ASSIGNMENT 2 – Genesis of Scientific Knowledge – June 23th

Assignment 2: Tracing the Genesis of Scientific Knowledge

The purpose of Assignment 2 is for you to apply the ideas and concepts associated with the history and nature of science into contemporary research in science. By describing the discovery, the scientists, and the aftermath of publication, you should gain an understanding of what science is, how it works, and the character of scientific knowledge.

From your particular field of specialization, identify 1 current issue. For the issue you choose (and I approve), you must:

1) Identify and read an original publication
   a. What is the main point of the paper?
   b. What type of methodology did the researcher(s) use?
   c. What are the limitations of the study?
   d. How certain are the author(s) about their conclusions?
   e. Why is the paper significant to science, society, and education?

2) Find six secondary articles that report on the original publication.
   a. What do the six secondary articles have in common?
   b. How are they different?
   c. How has the meaning of the original paper been changed?
   d. How does the ‘spin’ affect our understanding of science and scientific knowledge?

3) Find an array of tertiary sources (textbooks, blogs, listservs, websites, video, audio, transcripts) that provide additional ‘spin’ on the original paper.
   a. What sources use the research for political purposes?
   b. What sources use the research for social/moral purposes?
   c. What sources raise doubt, concern, or suspicion?
   d. What sources imply certainty and absolute understanding?
   e. How do these tertiary sources further influence our understanding of science and scientific knowledge?

After addressing these questions regarding the primary, secondary, and tertiary sources, write a passage on the findings as you think it should appear in a
secondary science textbook for your content area. What does your textbook passage have to say about the nature of science and scientific knowledge?

**ASSIGNMENT REQUIREMENTS**

- Submission of paper
- A paper that addresses all questions identified above.
- Complete list of references used.

<table>
<thead>
<tr>
<th>Aspect of the assignment</th>
<th>Requirements</th>
<th>Points</th>
</tr>
</thead>
</table>
| Submission of your work  | - Please place ALL parts of your work in a plastic report cover.  
- Make sure you have spell checked your work.  
- Create a cover page for the assignment and please feel free to use clip art on this. The cover page needs (at a minimum): NAME OF COURSE; GRADE LEVEL; YOUR NAME; DATE  
- Number your pages lower right corner  
- Text should be double spaced 12 font Times New Roman (or equivalent)                                                                                         | 4 POINTS  
Criteria  
Appearance is professional and attractive.  
All aspects are in place  
Up to 2 points may be DEDUCTED if appearance is poor.                                                                                                       |
| Paper                    | - Technical aspects of writing (spelling, grammar, punctuation)  
- Clear statement of purpose  
- Evidence that topic is relevant to specified discipline and learning standards.  
- Addresses all questions within the context of the essay  
- Ideas are insightful and supported by both class readings and outside readings  
- Analysis is well thought out and focused on course issues  
- Conclusion summarizes the main points                                                                                                                       | 20 POINTS  
Criteria  
Writing is at the level of a Master’s level course and reflects advanced reasoning and thinking.                                                                 |
| References               | - References are used to support ideas effectively.  
- APA protocols for citations, quotes, and footnotes are used.  
- Bibliography is properly formatted, complete, and accurate.                                                                                            | 6 POINTS  
Criteria  
Accuracy and respect for professional protocols in writing.                                                                                               |
ASSIGNMENT 3 – Nature/History of Science Learning Project – July 3rd

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.
2) Design a series of activities students can do in class that address a specific concept related to your content area of expertise.
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.

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

1) Identify a focus question addressed by your work. The question is a fundamental tool in science education. A good question can motivate learning, focus classroom discussion, and direct classroom experiences. A good question is not answered in a sentence or a minute, or with one or two words. A good question can be left unresolved for weeks as classroom work allows for students to develop additional content understanding which can then be directed towards a more meaningful answer. By the end of the unit, students will be able to construct an answer to the question that draws upon multiple conceptual dimensions. The question should be:
   a. Open-ended
   b. Focus on a significant historical episode
   c. Allow for the important historical and contemporary individuals associated with the concept to be discussed.
   d. Address multiple learning objectives required by the Massachusetts Science Standards.
2) Provide a thorough explanation of the answer including pertinent scientists associated with the relevant research, concepts, and theories.
3) Identify the unit(s) within the MA Frameworks for which the project applies.
4) Identify all standards from the MA frameworks that directly connect to your questions’ solution.
5) For each standard, provide a brief statement that explains the connection between the standard and the focus question.
6) Provide a concept map for your project that links specific activities to specific standards or learning objectives.
7) Complete list of references for your information in APA format.
8) 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>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality of Question</strong></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Explanation</strong> of Solution</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality of Activities/Sites</strong></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Units</strong> where question could be used.</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MA Standards</strong> supported and brief explanations for each.</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Concept Map</strong></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual representation of the question and its connection with content.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oral Presentation</strong></td>
<td></td>
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<tr>
<td><em>Clarity</em></td>
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<td></td>
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<tr>
<td><em>Timing</em></td>
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<tr>
<td><em>Eloquence</em></td>
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<tr>
<td><em>Audience-contact</em></td>
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<tr>
<td><em>Answering questions</em></td>
<td></td>
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<tr>
<td><em>Appropriate powerpoint</em></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>YOUR TOTAL OUT OF</strong></td>
<td><strong>30</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ASSIGNMENT 4 – WEBBOARD - BY June 2/June 12/June 23

THE TASK
1. You will be required to log on to the web-board at:
   http://vappsrv-prd.umassonline.net/webct/cobaltMainFrame.dowebct
2. 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.

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