VIRTUAL SCIENCE FAIR

By David Consalvi

LESSON OVERVIEW:

This constructivist lesson involves a research project that each student will pursue for his or her final in each trimester course. The final product will be in a digital format to be posted to the class website and peer reviewed according to the specified criteria. The specific topic is student choice, but must be centered on a set of criteria and guidelines for the course. Technology will enable the students to develop a final presentation of the study and create a teaching tool for peers on their research. Technology will also be used to analyze the data gathered and enable a visual representation of findings. Students may use technology to gather data by using probes, cameras or other devices and collect background information on their subject.

ANALYSIS:

Learners and Audience:

- High school students in grades 9-12 science classes.

Prior Knowledge:

- Various science backgrounds – each student will choose a topic appropriate for their course work and interests.
- Various computing skills – all students had access to word processing and presentation software such as Microsoft Office or AppleWorks.

This lesson, presented at the start of the term but completed at the end, is geared towards high school students in grades 9-12. The earlier grades will have had access to computers in their 6-8 grade years from the Maine Laptop and Technology Initiative (MLTI). This program offered student access to Microsoft Office or AppleWorks for creating documents and presentations as well as other programs. Their ability to create a proper presentation for their target audience at the high school level will need to be modeled. During the duration of the course, students will be creating smaller presentations and reports from lab work and analyzing peer projects to develop this skill. They will have to learn proper design, format, and program usage. They will also need to be able to use advanced features of the programs such as embedding video, sound, or hyperlinks.

Aside from the technology component, students will need to develop their critical thinking skills for successful completion of the project. As they progress, they will be working with lab activities that encourage them to analyze data, to develop conclusions, and support results with understanding they get from readings and lectures. They will learn how to communicate their findings effectively as they produce their final product.

Currently, our student population receives their first experience with scientific inquiry when they enter high school. Prior to reaching the high school science lab they pursue only very basic activities or book learning for science. Because of this, there is a lot of remediation on the scientific method and how it sets a basic foundation for experiments. Also, the basic grammar and communication skills are deficient and need to be modeled

for a majority of the student population. For this reason, students will be utilizing a laboratory report template that guides them through the process of writing in a laboratory setting for the duration of the course.

They will be using the different technology throughout the course in various activities to learn the skills and will have to apply their understanding here. It is implied that this training will be enough preparation to enable them to succeed on this culminating project. However, technology will also act as a means to share and learn through the class website. They will have the opportunity to utilize a Moodle environment to communicate and assist each other in the course. So, technology is not only acting as a means to present information more effectively. Technology is facilitating learning by offering a platform to increase community learning and sharing.

DESIGN AND DEVELOPMENT:
Through independent research of a topic of personal interest, students are given the opportunity to have a choice in their education and gain valuable skills for life-long learning. Student led instruction increases the level of commitment to a particular project. By giving the students a virtual platform for their work, they gain meaning to their work furthering the perceived value. Lastly, by enabling students to play key roles in the judging of the products, they share information with their peers.

Technologies primary role in this lesson is to enable the students to convey their learning to their peers and a larger audience enabling a real-world application of their work. Typical posters and paper reports are limited in their scope for increasing audience understanding. Only a few individuals are able to view the posters and the amount of information presented is limited by print capabilities and lack sound or video. By developing a digital presentation of research that they undertake, students will be able to create a product that highlights their ability to identify a study system, develop a procedure to increase the understanding of the topic, carry out the study, gather and analyze data, formulate a proper conclusion from their investigation, and present the entire package to a wide audience. They create something of meaning to themselves and others.

Instruction Goals:

- Students will develop a greater understanding of a key scientific concept of interest from MLRs specific to their course (see Table 1).
- Students will develop greater awareness of scientific inquiry and its application.
- Students will verify, evaluate, and support results in a purposeful way.
- Students will develop greater computing and presentation skills.
- Students will improve communication skills.
- Students will develop skills using computers for analyzing and organizing data.
- Students will develop skills using technology to gather evidence and data.
- Students will assess validity of presented research and procedures.

Table 1: Maine Learning Results (MLRs) correlation to the appropriate science course for this research. Full description of the indicators is presented at the end of the plan.

1997 Maine Learning Results Grade 9 - 12	2006 Proposed MLRs (not in use yet)	Course Title
H1,2,3,4,5,7,8,I1,2,3	D1 D4 A B C	Science I – Physics Concepts
E1,2,3,4,5,6,7,F1,4,H6,9,I4,5,6	D3 A B C	Science II – Chemistry Concepts
A3,B1,3,4,D2,3,6,F2,3,5,6,G1,2,3	D2 E1 E2 E5 A B C	Science III - Ecology Concepts
A1,2,B2,C1,2,3,4,5,D1,4,5	E2 E3 E4 A B C	Science IV – Cell Biology Concepts
A2,B1,2,3,4,E2,3,5,F1,2		Weather / Oceanography
A2,B1,2,3,4,F1,2		Marine Resources

Resources, Media, and Learning Strategies:
The specific tools and strategies employed by each student will differ depending on the chosen research. However, all students will utilize some or all of the following: computers, graphics, organizational programs, imaging devices, and the Internet to complete their study.

- Computers – used to gather, process, organize, and present material – ex. Excel for tables, Word for word processing, PowerPoint for presenting, and iMovie for video editing.
- Graphics – used to increase the visual understanding of the concept being presented – ex. Excel graphs of data or diagrams of lab set-up.
- Organizational Program – used to analyze and formulate data into presentable forms – ex. Excel for calculations and graphing
- Imaging Devices – used to capture stages of the research for recording purposes – ex. Digital camera to capture the daily development of germinating seeds.
- Internet – used to gather background information on topic and provide the medium for sharing the final products.

Grappling's Technology Spectrum ranks most of this lesson in the Transforming Level. Bloom's Taxonomy would rank portions of this lesson in the Application, Analysis, Synthesis, and Evaluation levels. As a constructivist lesson, the student led research option offers choice and creativity as a means for students to demonstrate their understanding of scientific inquiry.

Project Sequencing:
Stage 1: Find your science interest. Students will first choose a topic and narrow it down to a specific area they want to study.
Stage 2: Design your research. Students will design a procedure and devise a list of materials to successfully complete the research.
Stage 3: Carry out your experiment and collect data. Students will plan and implement the procedures while organizing data and recording the experiment's progress.
Stage 4: Analyze the results and develop a conclusion. Students will analyze the results and look for evidence to cite in their conclusion that connects known theory with observed or learned.
Stage 5: Design and create your final products. Students will use digital technology to create a final presentation for the website as well as layout a large format poster for color printing.

Stage 6: Peer evaluations. Students will assess each other's work while being presented with an opportunity to learn more detail about a specific topic. They will use this process to exchange ideas and findings with each other and improve their potential for future projects.

Student Assessment:
Teacher and Peer Evaluation according to the rubric. The rubric is presented after the student assignment sheet.

IMPLEMENTATION:

- Students will need to commit to a topic within the first 3 weeks of the course and then meet various goals along the way. This creates challenges for students who have less background in science because they have less perspective about what interests them. There will need to be additional assistance in topic selection available.
- The implementation of this for a trimester system will require the students to begin the longer studies early in the course and not leave a lot of time to reflect. Students who fail to get a quick start will have to choose shorter studies that could limit choice.
- Overcoming the FERPA regulations about displaying student work may be an issue. Students will have to agree to post their work to the Internet for sharing or there may be issues. A parent permission form included with the course syllabus will hopefully overcome this challenge. Also, the work will be posted with pen names.

EVALUATION:

- Results of student appraisals of projects and the quality of the final products will indicate project success. Greater productivity indicates higher success.
- Peer evaluation responses will indicate how well students used the available tools to convey meaning and understanding.
- Students will complete an online survey through Moodle designed to evaluate the project and offer suggestions to improve it for future participants. The survey will be developed during and near the conclusion of the project to allow questions to take into account observed considerations.

Maine State Standards: (Specific project standards for A through I are dependent on student choice and class. Possible class standards are listed in Table 1.)
1997 MLR J1, 2, 3, K3, 4, L2, 3, 4, 7

GRADE 9 – 12 MAINE LEARNING RESULTS FOR SCIENCE: www.maine.gov

A. CLASSIFYING LIFE FORMS

1. Explain the role of DNA in resolving questions of relationship and evolutionary change.
2. Describe similarities and differences among organisms within each level of the taxonomic system for classifying organisms (kingdom through species).
3. Analyze the basic characteristics of living things, including their need for food, water, and gases and the ability to reproduce.

B. ECOLOGY

1. Illustrate the cycles of matter in the environment and explain their interrelationships.
2. Compare the process of photosynthesis and respiration, and describe the factors that effect them.
3. Analyze the factors that affect population size (e.g., reproductive and survival rates).
4. Analyze the impact of human and other activities on the type and pace of change in ecosystems.

C. CELLS

1. Relate the parts of a cell to its function.
2. Illustrate how cells replicate and transmit information, including the roles of DNA and RNA.
3. Discuss the function of the important "molecules of life" - proteins (including enzymes and hormones), carbohydrates, lipids, and nucleic acids.
4. Explain how the human body protects itself against disease and how the body might lose that ability.
5. Analyze and debate basic principles of genetic engineering: how it is done, its uses, and some ethical implications.

D. CONTINUITY AND CHANGE

1. Explain how mutations can be caused by gene mutation or chromosomal alteration and describe the possible results of such mutations on individuals or populations.
2. Describe why the offspring of sexually reproducing species have different survival rates than those of asexually reproducing species under a variety of conditions. Describe the advantages and disadvantages of each.
3. Explain and document the importance of relatively short-term changes (e.g., one generation) on a species' survival.
4. Describe how genetic manipulation can cause unusually rapid changes in species.
5. Compare and contrast fertilization, zygote formation, and embryo development in humans and other species.
6. Analyze a theory scientists use to explain the origin of life.
7. Explain both the evidence used to develop the geologic time scale and why an awareness of geologic time is important to an understanding of the process of change in the universe as well as on earth.

E. STRUCTURE OF MATTER

1. Trace the development of models of the atom to the present and describe how each model reflects the scientific understanding of their time.
2. Analyze how matter is affected by changes in temperature, pressure, and volume.
3. Describe the characteristics and behavior of acids and bases.
4. Describe an application of the Law of Conservation of Matter.
5. Describe how atoms are joined by chemical bonding.
6. Compare the physical and chemical characteristics of elements.
7. Describe nuclear reactions, including fusion, fission, and decay, their occurrences in nature, and how they can be used by humans.

F. THE EARTH

1. Describe how air pressure, temperature, and moisture interact to cause changes in the weather.
2. Analyze potential effects of changes in the earth's oceans and atmosphere.
3. Describe the impact of plate movement and erosion on the rock cycle.
4. Describe ways that scientists measure long periods of time and determine the age of very old objects.
5. Demonstrate how rocks and minerals are used to determine geologic history.
6. Analyze the changes in continental position and the evidence that supports the concept of tectonic plates.

G. THE UNIVERSE

1. Describe how scientists gather data about the universe.
2. Research current explanations for phenomena such as black holes and quasars.
3. Explain how astronomers measure interstellar distances.

H. ENERGY

1. Analyze the evidence that leads scientists to conclude that light behaves somewhat like a wave and

somewhat like a particle.
2. Examine and describe how light is reflected and refracted (deflected) by mirrors and lenses.
3. Explain or demonstrate how sound waves travel.
4. Analyze the relationship between the kinetic and potential energy of a falling object.
5. Use mathematics to describe the work and power in a system.
6. Describe the relationship between matter and energy and how matter releases energy through the processes of nuclear fission and fusion.
7. Use mathematics to describe and predict electrical and magnetic activity (e.g., current, resistance, voltage).
8. Compare and contrast how conductors, semiconductors, and superconductors work and describe their present and potential uses.
9. Demonstrate an understanding that energy can be found in chemical bonds and can be used when it is released from those bonds.

I. MOTION

1. Use mathematics to describe the law of conservation of momentum.
2. Explain some current theories of gravitational force.
3. Use Newton's Laws to qualitatively and quantitatively describe the motion of objects.
4. Describe how forces affect fluids (e.g., air and water).
5. Explain the relationship between temperature, heat, and molecular motion.
6. Describe how forces within and between atoms affect their behavior and the properties of matter.

J. INQUIRY AND PROBLEM SOLVING

1. Make accurate observations using appropriate tools and units of measure.
2. Verify, evaluate, and use results in a purposeful way. This includes analyzing and interpreting data, making predictions based on observed patterns, testing solutions against the original problem conditions, and formulating additional questions.
3. Demonstrate the ability to use scientific inquiry and technological method with short term and long term investigations, recognizing that there is more than one way to solve a problem. Demonstrate knowledge of when to try different strategies.
4. Design and construct a device to perform a specific function, then redesign for improvement (e.g., performance, cost).

K. SCIENTIFIC REASONING

1. Judge the accuracy of alternative explanations by identifying the evidence necessary to support them.
2. Explain why agreement among people does not make an argument valid.
3. Develop generalizations based on observations.
4. Determine when there is a need to revise studies in order to improve their validity through better sampling, controls or data analysis techniques.
5. Produce inductive and deductive arguments to support conjecture.
6. Analyze situations where more than one logical conclusion can be drawn.

L. COMMUNICATION

1. Analyze research or other literature for accuracy in the design and findings of experiments.
2. Use journals and self-assessment to describe and analyze scientific and technological experiences and to reflect on problem-solving processes.
3. Make and use appropriate symbols, pictures, diagrams, scale drawings, and models to represent and simplify real-life situations and to solve problems.
4. Employ graphs, tables, and maps in making arguments and drawing conclusions.
5. Critique models, stating how they do and do not effectively represent the real phenomenon.
6. Evaluate the communication capabilities of new kinds of media (e.g., cameras with computer disks instead of film).
7. Use computers to organize data, generate models, and do research for problem solving.
8. Engage in a debate, on a scientific issue, where both points of view are based on the same set of information.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

1. Examine the impact of political decisions on science and technology.
2. Demonstrate the importance of resource management, controlling environmental impacts, and maintaining natural ecosystems.
3. Evaluate the ethical use or introduction of new scientific or technological developments.
4. Analyze the impacts of various scientific and technological developments.
5. Examine the historical relationships between prevailing cultural beliefs and breakthroughs in science and technology.
6. Research issues that illustrate the effects of technological imbalances and suggest some solutions.

GRADE 9 – 12 NATIONAL SCIENCE CONTENT STANDARDS:
http://www.nap.edu/catalog/4962.html

UNIFYING CONCEPTS AND PROCESSES **Systems, order, and organization** **Evidence, models, and explanation** **Change, constancy, and measurement** **Evolution and equilibrium** **Form and function**	**SCIENCE AS INQUIRY** **Abilities necessary to do scientific inquiry** **Understandings about scientific inquiry**	**PHYSICAL SCIENCE** **Structure of atoms** **Structure and properties of matter** **Chemical reactions** **Motions and forces** **Conservation of energy and increase in disorder** **Interactions of energy and matter**	**LIFE SCIENCE** **The cell** **Molecular basis of heredity** **Biological evolution** **Interdependence of organisms** **Matter, energy, and organization in living systems** **Behavior of organisms**
EARTH AND SPACE SCIENCE **Energy in the earth system** **Geochemical cycles** **Origin and evolution of the earth system** **Origin and evolution of the universe**	**SCIENCE AND TECHNOLOGY** **Abilities of technological design** **Understandings about science and technology**	**SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES** **Personal and community health** **Population growth** **Natural resources** **Environmental quality** **Natural and human-induced hazards** **Science and technology in local, national, and global challenges**	**HISTORY AND NATURE OF SCIENCE** **Science as a human endeavor** **Nature of scientific knowledge** **Historical perspectives**

Virtual Science Fair

(student instructions)

Objectives:

- develop a greater understanding of a key scientific concept of interest.
- develop greater awareness of scientific inquiry and its application.
- verify, evaluate, and support results in a purposeful way.
- develop greater computing and presentation skills.
- improve communication skills.
- develop skills using computers for analyzing and organizing data.
- develop skills using technology to gather evidence and data.
- assess validity of presented research and procedures.

Stage 1: Find your science interest

This is your opportunity to choose a topic of interest to you and study it in greater depth. You will select the important concept and think of a way to perform a research study of that topic. To do this, you should look through the course outline and familiarize yourself with possible areas of study. After finding some that seem appealing, do research using the Internet or other sources on that topic. If it meets the course and your criteria, try to develop a way to study the concept. Remember to document your sources for later use and possible citation in the final documents.

Keep in mind that the particular study you complete does not need to cover the entire topic but may focus on a portion. For example, if I were interested in photosynthesis. I could develop a study to look at the different pigments in plant leaves and see what wavelengths of light are most absorbed by the plant using a spectrophotometer. Although the larger topic is photosynthesis, my particular research will only look at the wavelengths of light in the visible light spectrum absorbed by the plant. It then relies on background information from other sources to complete the connection of light and photosynthesis.

*****10 points*****Submit your topic and general study description to the class discussion forum labeled Research Topics. Only one student may perform the same study, so it will be a first come first serve basis depending on when the topic is posted to the forum. You may also post additional ideas to share with your peers.

Stage 2: Design your research.

Once you have chosen your topic and narrowed it down to something you can study on your own, you will need to develop a specific set of materials and procedures to test. This should be like the lab reports you have done for class activities. Your instructor may be able to provide access to resources at the school given enough notice; however, it is your responsibility to plan and schedule access to these. Items that are specific to your study are your responsibility to obtain and are not going to be provided. Using the previous example, it would be possible to schedule access to the spectrophotometer and the materials for it, but the plant material would be the student's responsibility.

While developing the procedure, remember to include suitable controls for the experiment so that you can identify what caused the results. For example, if you are germinating seeds and some are in moist paper towels in the dark and others are on a dry counter in the light, it would be difficult to be certain if the moisture or light caused a difference in results. Label the controls in your procedure to be sure that all foreseeable issues are covered.

Also, the number of repetitions is important to increase validity of the experiment. Remember the idea of "heads or tails" with a normal penny. The odds of getting either result are 50%, but if you flip the coin 3 times you may get 3 heads. Does that mean that it is 100% chance the 4^{th} flip will be heads? Definitely not. The more times you flip the coin, the more the results validate that there is a 50 / 50 chance of getting "heads or tails."

Another major consideration in the design needs to be what data will be collected and how. How often will you take measurements, what measurements will be taken, when will you take the measurements, and how will you organize the data are all important considerations. Remember that quantitative data is usually easier to draw concrete conclusions from than qualitative.

*****40 points*****Submit your list of materials and complete procedure to the class website under the Research Journal area.

Stage 3: Carry out your experiment and collect data.
The plan you have completed now needs to be put into action. Be sure to watch the calendar and budget your time according to the plan that you have submitted. If your experiment takes 6 weeks to complete, you need to start early. If it only takes 1 week, you should still get an early start incase something needs to be adjusted or does not go according to the design.

As your experiment progresses, be sure to collect plenty of data and document everything that happens. You should use a digital camera to take pictures of the setup and progress as well. The data should be organized into tables and charts to be analyzed. Video is also an option for your presentation.

Stage 4: Analyze the results and develop a conclusion.
Calculations should be done to make better sense of the data. Find the group averages or calculate totals as necessary. Remember to write the formula that is used into the procedure. Graphs and diagrams should be developed to support and present your evaluation of the results. Look for trends or abnormalities in the data.

Connect what you observed to the current research and information on the topic. Do your results make sense? Do the observed results follow the expected outcomes? Why did changes occur in one system from another? How did each system compare to the control? What specific data points are important and why? What specific data points support your conclusions?

Stage 5: Design and create your final products
Take time to think about what you want your final presentation of your work to look like. Create a diagram and outline of your thoughts to save time organizing. Your target audience for your presentation is educated high school students, so you should use appropriate terminology. This is where you are going to show off what you have learned and your talents. It needs to follow a few guidelines in the rubric, but you have the opportunity to use creativity as well.

Use the model PowerPoint format, accessible on the class website, to create a digital poster of your research. This will be a part of your digital presentation. The remainder of your presentation will basically be a breakdown of this poster's parts with greater explanation and extras. You should use sound, video, pictures, or hyperlinks to external websites where appropriate to better enhance the presentation or increase clarity of ideas. If you found a good website on your topic during your research phase, you may want to use that during the presentation.

Firstly, you will need to include background information on your topic. What is it? Why is it important? How does it connect to local, national, and global issues? When did it become known or identified? Who is using this information or studying the topic?

Secondly, you will need to provide the specifics of your research. This is where you go into depth on your procedure, data collection, and analysis. You should do this by presenting the digital images of the lab setup. Present the important data points by highlighting and explaining the key elements. Show the analysis of the data and explain any graphs or calculations that were important.

Finally, present your conclusions and the connections of your work to prior knowledge on the topic. The conclusion is critical to summarizing all of the work done to this point. You should be sure that it reads well and that you connect your work and specifics from the data to the topic. If your data conflicts with the published information you should give possible explanations why. Do not assume that you are wrong and everyone else is right. Analyze what you did differently and see what explanations made your results turn out the way they did. If everything worked perfectly, then again you should explain the connection and the topic clearly. At no point in your conclusion should you say, "This was fun and everything worked well." I hope that is so and am happy to hear it, but it is not appropriate for your conclusion (just a reminder).

Proofread and self assess your work. It is always a good idea to have a couple other people appraise your work and revise before submitting the final presentation. This is a good way to see if you have effectively communicated what you wanted to your audience.

*****200 points*****Submit your final presentation to the class website for peer review. Also, email a copy of the PowerPoint poster to your instructor for printing. The file should be named *yourlastname_Research Topic_FINAL*. For example, I would submit my work as Consalvi_Photosynthesis_FINAL. All files should be able to be opened on a

class computer. Check with your instructor if you are not sure what acceptable programs and file extensions are. It is suggested that you use PowerPoint for this part because it is what the template is.

Stage 6: Peer evaluations

*****50 points*****Using the project rubric, you are to evaluate at least 5 different projects from the class website. These evaluations should be submitted by paper copy in class. Each evaluation is worth 10 points.

Project Name:_____

Evaluator:_____

Student Evaluation Form (circle the best score choice and comment why that was chosen (give constructive criticism so the project may improve))

Activity	Fails to complete assignment	Unsatisfactory (does not completely fulfill assignment requirements)	Satisfactory (partially fulfills assignment requirements)	Good (completely fulfills assignment requirements)	Excellent (Does a wonderful job of fulfilling the requirements)
Appearance Professional and neat. (10 points total)	0	2	6	8	10
Heading Descriptive and complete. (10 points total)	0	2	6	8	10
Purpose / Objective Statement of intent or purpose of the experiment. (10 points total)	0	2	6	8	10
Hypothesis Discussion of essential background information and logical and justified prediction of experiment. (20 points total)	0	4	12	18	20
Materials Accurate list of required materials for experiment. (10 points total)	0	2	6	8	10
Procedure Descriptive summary of steps to complete the experiment. (20 points total)	0	4	12	18	20
Data Clearly organized data collected and presented. (10 points total).	0	2	6	8	10
Analysis and Calculations Includes equations, calculations, graphs, illustrations, etc. (40 points total)	0	10	28	38	40
References List of any resources used to assist in understanding / writing. (10 points total)	0	2	6	8	10

Technology Use Uses appropriate audio, video, pictures, graphs and text to convey meaning. (10 points total)	0	2 – uses 1 or more types of the following: video, audio, pictures, and graphs	6 – uses 2 or more types of the following: video, audio, pictures, and graphs	8 – uses 3 or more types of the following: video, audio, pictures, and graphs	10 – uses 4 or more types of the following: video, audio, pictures, and graphs
Technology Presentation Design, creativity, color, fonts, etc. have aesthetic appeal. (10 points total)	0	2	6	8	10
Technology Flow Navigation, organization, and transitions smooth. (10 points total)	0	2	6	8	10
Technology Content All required material and information present. (10 points total)	0	2	6	8	10
Mechanics i. e., spelling, grammar. (10 points total)	0	2	6	8	10
File identification naming (10 points total)	0	2	6	8	10
Total Possible					200/200 = 100%

What was the main topic of the project?_____

How does this relate to or impact local and global communities? How is this information applied in real life? _____

What questions do you still have about the project?_____

What suggestions do you have to improve the project and its presentation?_____